A LEARNING DOMAIN-BASED TRAINING APPROACH FOR SMALLHOLDER IRRIGATED MAIZE FARMING IN MASHONALAND CENTRAL PROVINCE OF ZIMBABWE

Livinia Binala

(Student Number: 15018558)

A thesis submitted in fulfilment of the requirements of the Doctor of Philosophy in Rural Development (PHDRDV) Degree

Institute for Rural Development

Faculty of Science, Engineering and Agriculture

Promoter	**:**	Prof J. Francis
Co-Promoter	**:**	Dr T.Mupetesi

July2024

DECLARATION

I, Livinia BINALA, hereby declare that this thesis for the Doctor in Philosophy in Rural Development (PhDRDV) submitted to the Faculty of Science, Engineering and Agriculture at the University of Venda has not been submitted previously for any degree at this or another university. It is original in design and in execution, and all reference material contained therein has been duly acknowledged.

Student  **Date** 15 February 2023

Livinia Binala

ABSTRACT

The study was carried out to investigate the effectiveness of training approaches for smallholder irrigated maize farmers in Zimbabwe, particularly their crucial role in national food security and rural livelihoods. Despite irrigation's potential to boost productivity of maize, many farmers encountered challenges in adopting improved practices partly due to inadequate training methods. Thus, the study sought to evaluate current training frameworks and propose a comprehensive model integrating Bloom's taxonomy of learning domains to enhance knowledge acquisition and practical skills among farmers.

The objectives of the study were 1) to identify the key learning domains for effective use of irrigation technologies in smallholder maize farming in Mashonaland Central Province 2) to propose a training approach that is tailored to the identified learning domains and the specific needs and constraints of smallholder farmers in Mashonaland Central; 3) to evaluate the effectiveness of the developed training approach on the productivity and income of smallholder maize farmers in Mashonaland Central Province; and 4) to assess the effectiveness of the developed training approach in improving the knowledge and skills of smallholder farmers in the use of irrigation technologies for maize farming. Three irrigation schemes that focused on maize production and located in two natural regions, that is, II and IV within Mashonaland Central Province were purposively selected. Proximity to the Harare, the capital city or extent of the scheme's rurality was considered. The census method of data collection was applied. All the 472 farmers involved in irrigation in the three schemes were earmarked for the questionnaire-based survey.

Employing a mixed-methods approach, the study combined quantitative surveys and qualitative interviews with farmers and agricultural extension officers across the three irrigation schemes. Key findings indicated that Farmer Field Schools (FFS) significantly outperformed traditional Master Farmer Training (MFT) in promoting effective learning and adoption of sustainable practices ($P < 0.05$). The study underscored the importance of participatory training methods, which resonate more effectively with farmers' needs and educational backgrounds. Using the results of the study, a framework that includes the following as the key components was proposed:

a) Incorporation of cognitive, affective, and psychomotor learning domains
b) Prioritization of hands-on training with visual aids
c) Promotion of sustainable farming practices
d) Strengthening of farmer-extension linkages
e) Investment in teaching materials and monitoring mechanisms

This study advocated for a paradigm shift in agricultural training methodologies. Adopting the recommended framework would enable policymakers and practitioners to significantly enhance the productivity and livelihoods of smallholder maize farmers, thereby contributing to improved food security. Furthermore, the study highlighted the need for deploying participatory and practical training, addressing key skills gaps, in addition to developing robust farmer-extension relationships to achieve these goals. Integration of Bloom's learning domains into farmer training curricula is a strategic roadmap for designing more effective and impactful training of smallholder irrigated maize farmers.

Keywords: Food security, Irrigation, Frameworks, Bloom's Taxonomy, Participatory training methods, Smallholder maize farmers

To my late father, Jethro, sisters Honest and Gerifa Manyepa who have always wanted to see me reach this far. This is for you. Your dreams have come to pass.

ACKNOWLEDGEMENTS

I would like to express my greatest appreciation to the Almighty, who has been and will always be my source of hope and strength. Lord, you make all things beautiful in the fullness of time. It was not an easy journey, but you kept me going.

My sincere gratitude goes to my promoters Professor J. Francis and Dr T Mupetesi. Your support, guidance, encouragement and unwavering support were most valuable. Many thanks go to the smallholder farmers in Mashonaland Central Province who contributed to this study in a huge way. They accommodated me and took off time from their busy schedule to entertain me and my endless questions. Extension officers at the three irrigation schemes, I am also indebted to you. You made this study possible.

To, Professor Innocent Chirisa, I would like to thank you for your unwavering support. You have become one of my best mentors. I want also to thank staff in the Agricultural Economics Department of the University of Zimbabwe, when I started this journey. I was knocking on your doors. Your insightful discussions and commenting helped me to be where I am today. Special mention goes to Mapangisana Toga and Alistair Mubvirwi for helping out with the data analysis.

Special thanks go to my family and friends for believing in me. I acknowledge with love. To JB and the trio – Enias, Adrian and Tadiwa, I love you guys. My first baby girl Farai, thank you for being there for me. To the ladies of the house *Hailey Matida and Heaven Matipa Binala*, I know you will follow grandma's footsteps.

TABLE OF CONTENTS

LIST OF TABLES

Page

LIST OF FIGURES

Page

ABBREVIATIONS

AGRITEX	-	Agricultural Extension Services
ARDAS	-	Agricultural Rural Development Advisory Services
CD	-	Community Development
DOI	-	Department of Irrigation
FAO	-	Food and Agricultural Organisation
GDP	-	Gross Domestic Product
GOZ	-	Government of Zimbabwe
FGD	-	Focus Group Discussion
FFS	-	Farmer Field School
FPRA	-	Farmer Participatory Research Appraisal
HSD	-	Human Scale Development
KAP	-	Knowledge, Attitudes, Practices
MDG	-	Millennium Development Goals
MALFWRD	-	Ministry of Agriculture Lands Fisheries Water and Rural Development
MoAMID	-	Ministry of Agriculture Mechanisation and Irrigation Development
MFT	-	Master Farmer Training
NFPL	-	National Food Poverty Line
NGOs	-	Non-governmental Organisations
O & M	-	Operation and Maintenance
TCPL	-	Total Consumption Poverty Line
TFT	-	Training for Transformation
TOT	-	Training of Trainers
SDGs	-	Sustainable Development Goals
SIS	-	Small-scale Irrigation Schemes
SSA	-	Sub-Saharan Africa
SLF	-	Sustainable Livelihood Framework
UN	-	United Nations
ZIMSTATS	-	Zimbabwe Statistical Agency
ZIMVAC	-	Zimbabwe Vulnerability Assessment Committee

CHAPTER 1: INTRODUCTION

1.1 Background

Irrigation schemes provide socio-economic benefits to both the community and the country at large. These schemes act as catalysts for better livelihoods in communities through poverty alleviation accounting for over 60 % of the developing countries' entire population. Smallholder farmers play a crucial role in food security in many developing countries, including Zimbabwe. However, due to various challenges such as limited access to resources, inadequate knowledge, and low technology adoption, smallholder farmers often face productivity and income constraints. Soneye (2014) argues that of the 70 % land utilised by agriculture in sub-Saharan Africa, it contributes 50 % of the Gross National Product. However, it was noted that maize farmers participating in irrigation schemes in Zimbabwe just like in any other SSA country and globally continue to fail to produce enough for their own consumption as most of the irrigation schemes are not performing as expected. It has been noted throughout Africa that there is little evidence of successful and sustainable farmer-managed examples. This is in contrast to the view that SIS offer great potential to improved crop production, secure income and employment (Nhundu & Mushunje, 2010). About 0.1 million hectares in South Africa, are under smallholder irrigation. It is further noted that 50-75 % of these plot holders lived below the poverty line. A study carried out at Dzindi irrigation scheme in Limpopo Province of South Africa (Averbeke & Mohamed, 2012) reveals that the poverty rate was 62 % among the plot holders. Dossah *et al.* (2003); Settle (2014) and Binala (2016) in their various studies attributed poor performance of SIS in SSA to inadequate training. Nkabule & Dhlamini (2013) similarly concludes that low yields at Maplotini irrigation scheme in Swaziland were due to limited knowledge. Fanadzo *et al.* (2010) and McCarty (2015) attributes the poor performance of small-scale irrigation schemes in South Africa and Ethiopia respectively to the same factors. However, in Zambia, positive results were realised when maize farmers more than doubled their yields after training and adoption of high-yielding hybrid seed, soil protection measures and use of fertiliser. This is an indication of the value of irrigation schemes, yet inadequate attention is afforded to smallholder farmers in terms of skills and knowledge acquisition by policy-makers.

An estimated 27 million people in Southern Africa are food insecure due to droughts and inappropriate or inadequate farming methods (Clark, 2015). Zimbabwe is agrarian based as most people earn a living from agriculture yet the demand for maize overtakes the supply. The unreliable and erratic rainfall makes dry land cultivation a risky venture. As argued by Rukuni & Eicher (1994) and Mutambara & Munodawafa (2014), the success rate of rain-fed agriculture in the extensive farming regions IV and V of the country is one good harvest in every four to five years, hence, food shortages continue to haunt Zimbabwe. There

are increased droughts and flooding that require a shift in crops and farming practices (Mawere *et al.,* 2018). Smallholder farmers under irrigation schemes were and are still better placed than those without schemes. Farmers with no irrigation facilities are always counting their losses even in times of abundant rain as they are not able to collect and harvest the water for later use. The GoZ is planning to increase irrigation hectarage from 175 000 to 250 000 hectares through the Accelerated Irrigation Programme. These are measures to minimise shocks associated with uneven rainfall in the agriculture-reliant livelihoods (MALFWRD, 2022). ZimVac (2022) reports that nationally, there are 202 functional irrigation schemes whilst 82 are non-functional. During the 2020 -2021 cropping season, maize remained the most grown crop (84 %). Average maize stock per household was 70 kgs nationally. An increase of 6 % in the acceptable diet in households was realised in 2022, hence there was an improvement on food consumption pattern nationally.

The non-performance of SIS has seen Zimbabwe continually importing maize from the region but in times of regional drought, maize imports from other continents become very expensive. The importation of maize is done against a background of the availability of perfect farmland in the country. To improve self-sufficiency, the revamping of irrigation schemes and capacity building of personnel involved in agriculture sector is necessary to bring back Zimbabwe to its net food exporter in Southern African Development Community (SADC). UN World Food Programme estimated that up to 1.6 million Zimbabweans required food aid due to poor harvests in the 2014/2015 season. ZimVac (2020) reports that about 900 000 tonnes of maize were required to feed the population that was in dire need of the staple food after poor harvests during 2019/20 season. About 4.3 million rural Zimbabweans including children were estimated to be food insecure in 2020. Zimbabwe is quoted as one of the 10 countries where less than 20 % of children have proper diet. One in every 4 children under the age of 5 had stunted growth (UN, 2019). Irrigation development facilitates an increase of 2 t/ha of maize grain versus 1 t/ha produced by dry land farmers (MoAMID, 2012).

However, although there was an improvement in food consumption in 2022, it was projected that about 30 % of households would be food insecure (ZimVac, 2022). This is an indication that the GoZ still needs to continue revamping the partially functioning and non-functional irrigation schemes to ensure that households are food secure.

Mutambara and Munodawafa (2014) and Mutambara *et al*. (2014) argue that ARDAS officers lacked the requisite qualifications and experience commensurate with production levels in the schemes. Some of the extension officers were half baked having undergone only six months of training. Although the Government

of Zimbabwe tried to support the agricultural sector by providing various types of support and training, they lacked focus on domains of learning. The learning domain theory provides a theoretical framework that can inform the development of effective training programs for smallholder farmers (Van Eerde et al., 2013). According to the theory, learning occurs within a specific domain, which is characterized by a set of interconnected concepts, procedures, and principles. Farmers are a group of people with different attitudes, skills, needs and potentials. There is need to build on the skills and knowledge base of the new smallholder farmers as they join irrigation schemes. Manpower development and training is an important aspect of irrigated agriculture. Training is dynamic and its elements cannot be left for long without the possibility of their becoming stagnant or outdated. In recent years, there has been growing interest in the use of digital technologies to support smallholder farmers in developing countries. For example, mobile phone-based interventions have been used to provide farmers with market information and weather forecasts, and to facilitate access to credit and financial services (Aker *et al.,* 2016). However, the effectiveness of these interventions is not well-understood, and there is a need for more research to understand the potential of digital technologies to support smallholder farmers. The Zimbabwean government has recognised the importance of agriculture in poverty reduction and economic development and has implemented various programmes to support smallholder farmers. Farmer Field Schools, Training and Visit System and Master Farmer Training are some of the approaches that were used and are still in use to train farmers. However, these programmes have been criticized for being too general and not addressing the specific needs of smallholder farmers (Kanyama-Phiri *et al.,* 2018). There is a need for more targeted and context-specific training programmes that cater to the unique needs of smallholder farmers in Zimbabwe. Given the challenges facing smallholder farmers in Zimbabwe, there is a need for training programmes that are specifically designed to address their needs and constraints. Training programmes should focus on building the capacity of smallholder farmers to make effective use of irrigation technologies that can help to reduce the dependence on rain-fed agriculture and improve their crop yields (Makate *et al.,* 2016). Irrigated maize farming is an essential agricultural practice for smallholder farmers in Zimbabwe, as maize is the staple food crop in the country. Under the right conditions, irrigation pays by addressing the challenges of food insecurity felt increasingly since the 1990s much as in the 1950s when irrigation agriculture was developed in Zimbabwe. Rural-urban migration could be gradually reduced as many youths would be engaged in viable irrigation farming (Bagson & Kuuder, 2013).

This research aims to investigate the effectiveness of a learning domain-based training approach in improving the knowledge and skills of smallholder farmers in Mashonaland Central Province of Zimbabwe on irrigated maize farming. Specifically, the research will assess the impact of the training approach on the participants' knowledge and skills, and their adoption of improved farming practices. The study also

aims to making a positive contribution to the body of knowledge on studies that have chronicled the failures of irrigation schemes in Zimbabwe and mapping a way forward to get maximum output from irrigated maize farming.

1.2 Statement of the Research Problem

Although small-scale irrigation schemes were introduced in Zimbabwe to enhance food and nutrition security in rural areas, there are still concerns regarding their substandard performance. To date the GoZ has managed to increase irrigable land to 200 000 hectares. There are also 202 functional irrigation schemes and 82 non functional schemes that need to be developed (MALFWRD, 2022). Farmers work in designated irrigation schemes, yet there is rarely any significant output in situation of appreciable water security and readily available land needed for successful cultivation (Mupaso, 2014). Smallholder farmers in Mashonaland Central Province of Zimbabwe face numerous challenges related to low productivity and low income, including poor access to markets, limited storage facilities and limited access to credit and financial services (Matondi *et al.,* 2017; Zhou *et al.,* 2019). In addition, these farmers often lack the necessary knowledge and skills to effectively use irrigation technologies to improve their crop yields (Makate *et al.,* 2016). While there have been efforts to provide training programmes for smallholder farmers in Zimbabwe, these programmes have often been ineffective due to lack of consideration of the specific needs and constraints of these farmers (Mugabe, 2015). Maize farmers in irrigation schemes continue to fail to produce enough crops for their own consumption, resulting in them needing food aid thereby relying on food hand outs (AGRITEX, 2010; FAO, 2010, 2013, 2022; MALFWRD, 2020). It was estimated that about 4.3 million people in rural Zimbabwe were to be food insecure during the period 2019/2020 season. The period required at least 9 000 tons of maize to feed the vulnerable communities. Government provided (21.9 %) in food aid nationally in the period 2021 -2022 (ZimVac, 2022). Results of ZimVac (2023) report indicate that 26% of rural households were to be cereal insecure during the period January – March 2024. Of the approximated 2.7 million people requiring food aid, Mashonaland Central records 31% of households requiring cereal aid (ZimVac, 2023).Questions are then raised by stakeholders regarding the effectiveness of training approaches used to equip the farmers with the necessary competences and capabilities to farm effectively. Mupaso *et al.*(2014), after studying smallholder irrigation schemes in Chirumanzu communal area of Masvingo Province, recommends that agricultural training be provided to farmers involved in the schemes to enhance their productivity. The purpose of agricultural training is not for practical use only but also to encourage adoption by farmers of the new practices and technologies. Irrigation facilitates increased maize production of 2t/ha of maize grain versus 1t/ha acquired on dry land. If agriculture in Zimbabwe is going to have a strong and sustainable future, then investment

must be done on the most important resource that is the people in the farming sector (Binala, 2016). Education is vital in the agricultural sector to ensure the component of longevity for better livelihoods through food security in households.

A study by Nhundu & Mushunje (2010) reveal that farmers performed below average and the major irrigation crops were below the required standard. The same study showed that 65 % of the farmers in the irrigation schemes do not have relevant training. The Food and Agriculture Organisation and Agricultural Extension Services in 2010, carried out evaluative studies that mainly focused on the socio-impact of smallholder irrigation schemes in Mashonaland Central, Mashonaland East, Mashonaland West and Manicaland Provinces but did not study the domains of learning as they are applied in the training of smallholder farmers' arena.

Therefore, the problem addressed by this study is the lack of an effective and contextually appropriate training approach for smallholder irrigated maize farming in Mashonaland Central Province. This study aims to improve and evaluate a learning domain-based training approach that is specifically designed to address the needs and constraints of smallholder farmers in this province. This training approach will focus on building the capacity of smallholder farmers in the province for enhanced productivity to avert importation of maize that has been realised since 2000. The training approach will also focus on building the capacity of smallholder farmers to make effective use of irrigation technologies that can help to improve water use efficiency through adoption of water saving and moisture observation technologies. By addressing these challenges, the training approach has the potential to significantly improve the livelihoods of smallholder farmers in Zimbabwe and across the globe. The study will also unravel other reasons for poor productivity apart from training.

1.3 Justification of the Study

The primary focus of this study meant to assess the extent to which the cognitive, affective and psychomotor learning domains have been applied in the training of farmers involved in irrigated maize in three smallholder irrigation schemes (SIS) of Negomo, Eben and Chimhanda in Mashonaland Central Province of Zimbabwe. The development of irrigation schemes was seen as a famine relief strategy by the Government of Zimbabwe. It was also a move for smallholder farmers to be able to be self-sufficient through management of their own schemes than waiting for the government (Rukuni, 1986; AGRITEX, 2010; MoAMID, 2014). The government's emphasis was to reduce dependency on rain-fed agriculture where it was possible. The goal was to eradicate poverty and hunger in communities as argued by set Millennium Development Goals of 2000 by global leaders. Adeniyi & Ojo (2013) posit that 820 million

people in developing countries are affected by hunger. The number of hungry people is said to be growing at an alarming rate therefore, failing the MDG goal of food security by 2015 and revised SDG by 2020 now elevated to transforming the world by 2030 (Zimbabwe Voluntary National Review, 2021).

This study is significant in several ways. Firstly, it will contribute to the existing body of knowledge on smallholder farming in Zimbabwe by providing insights into the learning domains required for effective use of irrigation technologies in smallholder maize-farming communities. This information is critical in developing training programmes that are tailored to the specific needs and constraints of smallholder farmers in their localities.

Secondly, this study will provide a contextually appropriate training approach for smallholder farmers that can improve their knowledge and skills in the use of irrigation technologies for maize farming. This approach has the potential to increase crop yields and reduce dependence on rain-fed agriculture that could lead to improved food security and increased income for smallholder farmers.

Studies undertaken by AGRITEX (1999, 2010) and FAO (1999, 2010) indicate that formal smallholder irrigation schemes initiated and constructed by the government have performed poorly and are not sustainable. The examination of the learning domains helped in the establishment of why these schemes are failing to produce or perform as expected. (Settle, 2014) is of the view that farmers need to be capacitated for them to appreciate and be able to adapt and adopt the new approaches available to get better yields through irrigation systems than dry land farming.

Thirdly, this study will evaluate the effectiveness of the developed training approach in improving the productivity and income of smallholder maize farmers in Mashonaland Central Province. The findings of this study will provide evidence to support the use of the developed training approach in improving the livelihoods of smallholder farmers in other areas of Zimbabwe and other countries in the region. Maize was chosen because it is Zimbabwe's staple food with shortages faced both in urban and rural areas. There is potential to increase food supply to meet the demand from irrigated agriculture than from rain-fed agriculture.

Finally, this study will identify the key factors that influence the adoption and sustainability of the developed training approach among smallholder maize farmers in Mashonaland Central Province. Studies on SIS undertaken outside Zimbabwe did not apply learning domains in the training of farmers though most of them recommended further training of farmers in various projects. This information will be useful in

developing strategies to promote the adoption and sustainability of the developed training approach and to scale up its implementation in other areas. Overall, this study has the potential to make a significant contribution to the development of sustainable agriculture and rural livelihoods in Zimbabwe and beyond.

1.4 Research Objectives and Related Questions

The main objective of this study was to determine if and how the cognitive, affective and psychomotor domains of learning were applied in the training of farmers involved in irrigated maize production in three irrigation schemes located in Mashonaland Central Province of Zimbabwe. This was done to assess the causes of smallholder irrigation farmers' failure to produce maize effectively. The main objective was addressed through addressing the specific objectives listed below. Respective research questions, null hypotheses and decision rule are also presented:

Specific Objective	Research Question	Null Hypothesis (H_0)	Decision Rule
1. To assess the application of Bloom's learning domains in the training of farmers in irrigated maize production	How are Bloom's learning domains applied in the training of farmers in irrigated maize production?	H_0: Bloom's learning domains are not significantly applied in the training of farmers in irrigated maize production.	Reject H_0 if Bloom's learning domains are found to be significantly applied; fail to reject H_0 if no significant application is observed.
2. To evaluate the integration of Bloom's learning domains in the training programs for farmers involved in irrigated maize production	To what extent are Bloom's learning domains integrated into the training programs for farmers involved in irrigated maize production?	H_0: Bloom's learning domains are not significantly integrated into the training programs for farmers.	Reject H_0 if evidence shows significant integration of Bloom's learning domains; fail to reject H_0 if integration is not significant.
3. To determine the effectiveness of applying Bloom's learning domains in improving practical skills of farmers in irrigated maize production	How effective is the application of Bloom's learning domains in improving the practical skills of farmers in irrigated maize production?	H_0: The application of Bloom's learning domains does not significantly improve the practical skills of farmers.	Reject H_0 if the application of Bloom's learning domains is found to significantly improve practical skills; fail to reject H_0 if no significant improvement is observed.
4. To suggest an improved framework for integrating cognitive, affective, and psychomotor domains in training	What framework can be suggested for better integration of cognitive, affective, and psychomotor domains in training programs for	H_0: An improved framework for integrating cognitive, affective, and psychomotor domains will not significantly enhance the	Reject H_0 if the suggested framework significantly enhances training effectiveness; fail to reject H_0 if no significant enhancement is observed

programs for irrigated maize farmers.	irrigated maize farmers?	effectiveness of training programs.	

1.5 Conceptual Framework of the Study

The conceptual framework (Figure 1.1) argues that farmers in the three chosen SIS were evaluated as to whether the production gaps that exist between the actual and potential output have been reduced or increased due to training received. This was measured in terms of participation, outcomes and impacts.

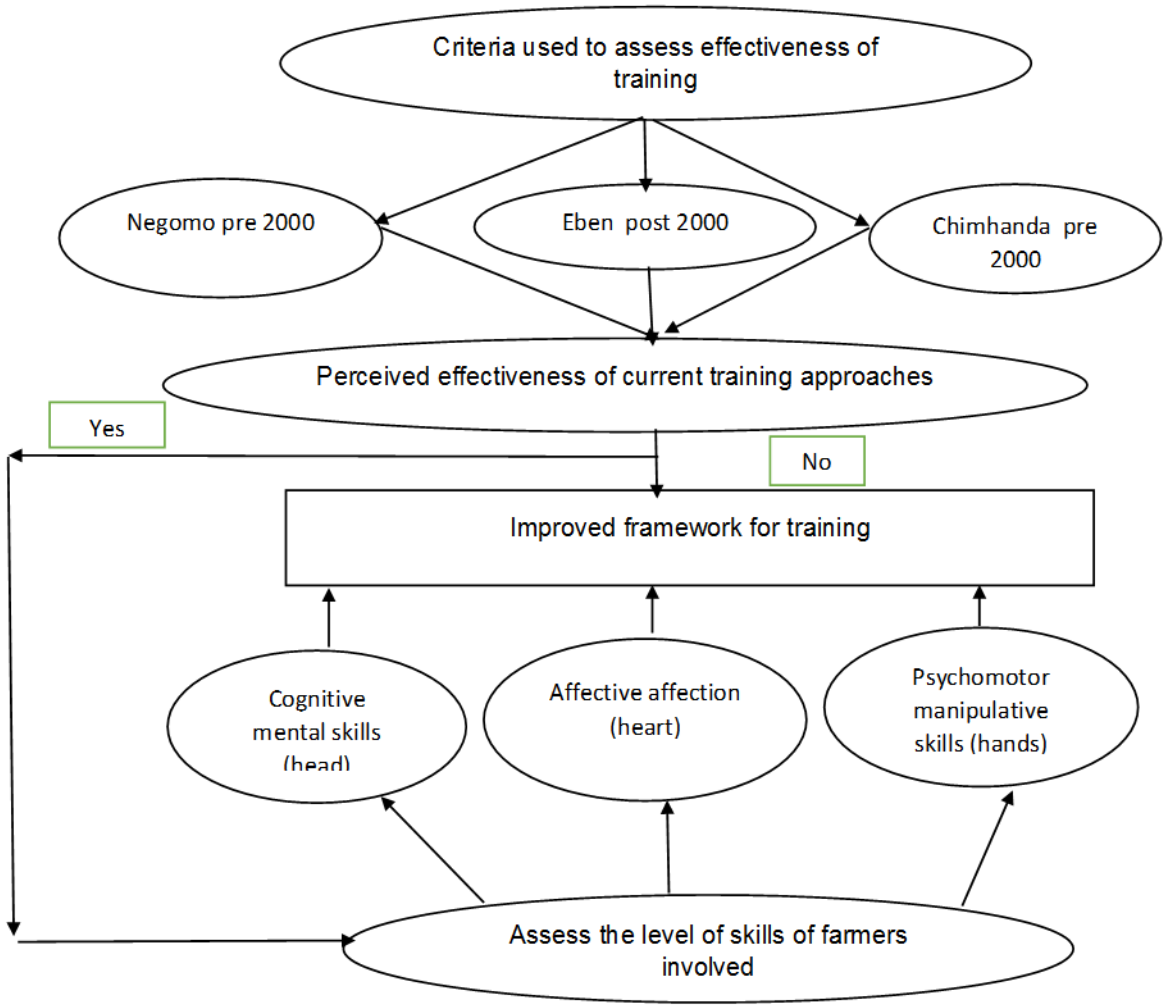


Figure 1.1: Conceptual framework for learning domain-based farmer training of farmers in irrigation schemes within Mashonaland Central Province of Zimbabwe

The effectiveness of these approaches and the newly introduced post-independence training approaches were examined. The knowledge, skills and attitudes of the farmers are anchored by the three domains of learning, namely cognitive, affective and psychomotor the foundation of all training and learning situations.

Focus was on the establishment of the effectiveness of the training sessions if the farmers were able to comprehend, change attitudes after training and apply using the psychomotor domain. Aim of the domains is to see a farmer who can make own decisions, adapt and adopt and being able to monitor and maintain the schemes' operations without waiting for the government or the donor. A self-actualised farmer is developed by eradicating the donor syndrome in our communities. Using this approach to the study enables the research to come up with an improved training approach framework with the assistance of the farmers. By doing so, population studied were able to assess the current training approaches thereby making own decision on the success and failures to recommend an improvement of the training approach anchored on Bloom's taxonomy of learning domains.

1.6.1 Theoretical Framework

The study was guided by the Social Learning Theory (SLT) proposed by Bandura (1977). Social Learning Theory posits that individuals learn from their environment through observation, imitation, and modelling, and that this learning can be reinforced through positive outcomes (Bandura, 1977). In the context of smallholder farming, SLT suggests that the adoption and effective use of new technologies by smallholder farmers can be facilitated through social learning processes, including observation, imitation, and modelling of successful adoption by other farmers in their community (Makate *et al*., 2016). The theory has been applied in several studies of technology adoption and diffusion in agricultural contexts, including studies of the adoption of improved crop varieties, irrigation technologies, and conservation practices (Mkumbwa *et al.,* 2018; Shiferaw *et al.,* 2011; Wossen *et al.,* 2017).

The study was also based on the Sustainable Livelihoods Framework (SLF) developed by the Department for International Development in 1999. The SLF posits that sustainable livelihoods are achieved through the building and strengthening of five key livelihood assets: human, social, natural, physical, and financial. The SLF has been widely applied in studies of rural livelihoods and poverty reduction in agricultural contexts (Ellis, 2000; Scoones, 2013), and has been used to assess the impacts of development interventions on the livelihoods of smallholder farmers in SSA (Haggblade *et al.,* 2010; Siziba *et al.,* 2020).

The combination of SLT and SLF in the present study provides a theoretical framework for understanding the learning processes and livelihood outcomes of smallholder farmers engaged in irrigated maize farming in Mashonaland Central Province. The framework emphasizes the importance of social learning processes in the adoption and effective use of new technologies, and the role of livelihood assets in achieving sustainable rural livelihoods. Theoretical framework was guided by Taxonomies of Learning Theory by Bloom (1956) a learning theory that differentiates levels of human mental capacity. It involves thinking,

learning and understanding. To this, it was coined to spell out the cognitive, psychomotor and affective domains (Anderson & Krathwohl, 2010). These domains by Bloom were the basis of this study. Learning occurs everywhere because people acquire mental and physical skills, in addition to developing new attitudes and mind sets when they perform day-day activities. Worldwide Bloom's Taxonomy of Learning Domains is commonly used when instructors design educational and training processes (Clark, 2015). In the context of this study, farmers were trained so that they gain and apply knowledge for adoption and efficient use of new technologies. Thus, the aim of the current study was to assess the level of these three domains in the affected farmers to resuscitate the irrigation schemes that were no longer functioning as expected to fulfil the SLT and SLF concerned with poverty eradication in rural communities.

These domains co-exist as each domain depends on the other for a successful human capital development. The rationale for developing extension services in countries is driven by the desire for the enhancement of farmer-human capital development. In this regard, Zimbabwe introduced economic development policies in the first decade of independence (1980-1990) with the aim of developing the country through citizen participation in the development process. Growth with Equity introduced in 1981 focused on the need to address the inherited inequalities mainly through land redistribution. Growth with Equity aimed at training, mobilising and utilising fully the country's human resources that are its creative and greatest asset. Taxonomies of learning domains are as summarised in Table 1.1.

Table 1.1: Summarised Bloom's taxonomy of learning domains and Evolution of Taxonomies of Learning Domains

Cognitive ***(Knowledge)***	**Affective** ***(Attitude)***	**Psychomotor** ***(Skills)***
Recall data	Receive (awareness)	Imitation (copy)
Understand	Respond (react)	Manipulation (follow instructions)
Apply (use)	Value (understand and act)	Develop Precision
Analyse	Organise personal value system	Articulation (combine integrate related skills
Synthesise	Internalise value system (adopt behaviour)	Naturalization (become expert)

Source: Ruhl (2021)

Evolution of Taxonomies of Learning Domains

Year	**Activity**
1956	Original 3 hierarchichal models of learning objectives by Bloom with collaborators: Max Englehart, Edward Furst, Water Hill, David Krathwohl.
1972	Anita Harrow revised to six levels
1972	Elizabeth Simpson progressed from observation to invention
2001	Revised by Lorin Anderson and David Krathwohl
2001	Revised by Robert Gagne
2010	Armstrong revised Bloom's original taxonomies as revised by owner in 1971
2015	Clark elaborated the affective domain in the 2nd handbook of Krathwohl et al. 1964
Recommendation	Blooms continue to provide teachers and educators with a framework for guiding the way they set learning goals for students and how they design their curriculum. All versions are revolving around the original theory by Bloom. This justifies why Blooms Taxonomies of learning domains theory was selected over the more recent ones.

Source: Author (2024)

1.7 Operational Definitions of Key Terms and Concepts

Cognitive or mental skills are mainly knowledge focused and attributes of one's ability. This involves remembering, understanding and applying learned material. It is a domain that helps to establish if the farmers can recall some processes that they would have been taught by extension officers. It helps farmers to be able to evaluate the learning process that they would be undergoing and make comparisons with previous sessions (Anderson & Krathwohl, 2010).

Affective: Growth in feelings or emotional areas (*attitude or self*). Attitude toward learning and development activity is evaluated – either positive or negative. If the farmers understudy value the training sessions arranged, they are seen by their readiness to learn. They respond by active participation in initiated programmes (Grunfield & Hoon Ng, 2013).

Psychomotor: These are manual or physical skills. Farmers should be able to use practical knowledge in combination with ability and understanding of tasks at hand after receiving training. The ability to perform a task without supervision or assistance with precision should be portrayed when assessing the psychomotor skills (Businessballs, 2017).

Extension Programme: A plan of the goals and target groups an extension organisation or extension unit tries to reach, and of the ways it will try to reach them (Sincero,2011; Hanyani-Mlambo, 2013). Extension agents organise a summary of a training course or programme that helps the farmers in irrigated maize farming to identify and analyse their production problems. This would help the farmers to move from subsistence farming to commercial thereby improving their socio-economic status and the country at large.

Knowledge, attitudes and practice (KAP survey) reveals what people know about certain things, how they feel and how they behave (Gamucio, 2011). In this study, it helps measure the changes in farmer knowledge, attitude and practice in response to the various types of trainings offered.

Community Development: Community development is both a process and product.. The approach emphasise self-help and building capacities for problem-solving. It is a holistic approach grounded in principles of empowerment, human rights, inclusion, social justice, self-determination and collective action (Kenny & Connors, 2017).

1.8 Organisation of thesis

Thesis is organised into five sections. Chapter 1 contains details on the introduction and background of the study, a statement of the research problem, justification or rationale of the study, research question or hypothesis. Objectives of the study are also highlighted starting with the main objective narrowing down to specific objectives and relevant questions. Theoretical and conceptual frameworks are outlined concluding with operational definitions of key terms and concepts.

Chapter 2 is the review of related literature to the study objectives of some studies that were undertaken by other scholars. Focus was on why farmers were failing to maximise production concluding with the synthesis of the chapter.

Chapter 3 the first part is the introduction then the description of the study area. The research design is stated with the sampling approach, data collection methods, techniques and tools. This chapter also outlines data collection methods, data analysis and interpretation as well as data presentation.

Chapter 4 are study findings focussing on specific objectives as outlined.

Chapter 5 is general discussion of findings presented in Chapter 4. Conclusions of the study, policy recommendations and implications are also discussed. These were based on inferences and Binary Logistic Regression analyses to come up with an improved training framework for farmers in irrigated maize farming or to dwell on the one that is currently in place for increased maize production in the SIS. The last section of the report presents references and appendices as attachments.

Chapter 6 highlights the summary, conclusions and recommendations of the study.

CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

Third world countries heavily rely on land and water resources as their life support systems. However, in many developing nations, these resources are dwindling, leading to increased poverty in rural communities that depend on agricultural production for their survival (UNDP, 2022). As a result, poverty eradication remains a top priority for numerous African countries. In Zimbabwe, the rural poverty rate is approximately 76 % (ZimVac, 2014, 2022), with the poverty rate in the study area of Mashonaland Central Province being around 73 % in 2014. A projection for 2022 indicates that over 50 % of households in the district will be cereal insecure. As spelt out in ZimVac (2022), 2.3 billion people worldwide were moderately or severely food insecure in 2021, with 924 million people (11.7 % of the global population) facing severe levels of food insecurity. This represents an increase of 207 million people in just two years. The Food and Agricultural Organisation (FAO, 2015) reports that 805 million people worldwide lack access to food and around 165 million children under the age of five suffer from stunted growth due to malnutrition during pregnancy or their second birthday.

Smallholder farmers play a crucial role in ensuring food security in many developing nations, including Zimbabwe. However, they often face productivity constraints due to limited access to resources, inadequate knowledge, and low technology adoption (Giller *et al.,* 2011). In Zimbabwe, smallholder farmers rely on irrigated maize farming for food security and income (Chapoto *et al.,* 2011). Nevertheless, smallholder farmers in Zimbabwe have limited access to training programmes and support services to improve their maize production skills (Mazvimavi *et al.,* 2013). The four pillars of food security are access, availability, safety, and stability (Jongwe, 2014). This study aims to improve the current farmer training approaches by generating results that will enhance training programmes for smallholder farmers.

In the sub-Saharan Africa (SSA), smallholder farming has been noted to be the prime form of agriculture accounting for 70 % of total food output (GoZ, 2019). Smallholder farmers in Zimbabwe produce over 70 % of the maize crop (FAO, 2017). Several challenges faced by the farmers limit their income and productivity. There is lack of access to modern technologies and information (Makate *et al.,* 2016). This is predominant for farmers who rely on rain-fed agriculture who succumb to climate variability and extreme weather events.

2.2 Smallholder Farming in Zimbabwe

In response to the crisis of food insecurity and rampant poverty, most developing countries including Zimbabwe, undertook major initiatives to help rural households improve their living standards and productive capacity (Makoye, 2013; Mupaso *et al.,* 2014). Central to this has been the establishment of smallholder irrigation schemes (SIS) in communal areas. This form of agriculture is viewed as the most viable means of reducing crop failure, hunger and malnutrition in Africa. Smallholder farming is a vital sector in the Zimbabwean economy, contributing significantly to national food security and the livelihoods of rural populations (Mapfumo *et al.,* 2020). Smallholder farmers in Zimbabwe face numerous challenges, including limited access to markets, finance, and extension services, poor water management practices, a lack of appropriate technologies and infrastructure (Makate *et al.,* 2016). Farmers also face the problems of insufficient knowledge of irrigation system maintenance and repairs. Climate change is also a growing threat to smallholder farming in Zimbabwe, with changing rainfall patterns and increased frequency of extreme weather events exacerbating existing challenges (Mapfumo *et al.,* 2020).

Smallholder irrigation schemes are known to be development initiatives implemented to capacitate smallholder farmers to be self-sustaining in the ownership and management of individual plots or community managed irrigation schemes (Underhill, 1990; Mupaso *et al.,* 2014; Moyo *et al.,* 2020). *Max-Neef* (1994) describe smallholder irrigation schemes as community development programmes that try to satisfy the needs in communities that are the same in all cultures. The basic needs to be satisfied are subsistence, protection, affection, understanding, participation, leisure and freedom as well as identity. In the absence of any of these needs, suggests that there is some form of poverty which needs to be addressed. This can only be done through needs assessment, implementation and evaluation to get to know the existing gap in the community that need to be fulfilled.

Zimbabwe irrigation sector has been divided into six sectors by the Zimbabwe Government Draft Irrigation Master Plan document of 2010 (A2, Large Private Estates, ARDA Estates, A1 and Old resettlement, Communal area and Wetland cultivation) in line with the farming sector. Smallholder irrigation schemes in Zimbabwe are classified as having (1) plots ranging from 0.1 – 1.5 ha as agreed in the land redistribution programme before 2000 and 0.1 – 5 ha to new classification that include A1 farmers (Zawe *et al.,* 2015). In this study smallholder

irrigation schemes refer to farmer managed irrigation schemes that use the same source of water and irrigation equipment to grow maize.

2.3 Historical development of irrigation schemes in Zimbabwe

Irrigation schemes were started by missionaries in 1912 when there was severe hunger in the country (Rukuni, 2006). Financial, technical and input support was provided, and the community offered labour. Through lessons learnt, farmers in the country became active participants in running and constructing irrigation schemes in various parts of the country. The knowledge and skills possessed by farmers were used for a better livelihood by following the teachings of the irrigation officer.

More schemes started developing in low rainfall parts of Zimbabwe after the success story of the pilot irrigation scheme in Mutambara. The thrust in the post-independence era was still on poverty alleviation, employment creation, enhancement of food security and curbing rural to urban migration (Rukuni, 1986). However, around 1945 government tightened the regulations and control of smallholder farmers' operations in irrigation schemes such that farmers viewed the irrigation schemes as government institutions a move aimed at controlling their fate. This created disharmony between farmers and the government. Large-scale irrigation was introduced in 1952 for increased and improved national food security (Scoones, 2013; Zawe *et al.,* 2015). After independence about 150,000 hectares of land were put under formal irrigation schemes in Zimbabwe.

Although irrigation development is considered as a gateway to increased agricultural productivity, increased household and national food security (Nhundu & Mushunje, 2010; Chazovachii, 2012) its development has been a major challenge in many developing countries. There are more failures than successes being recorded. The smallholder farming was and is still designated to the rural areas just like the farmer managed schemes in Zimbabwe. The community managed schemes that were introduced in 2009 in South Africa were reported to have discontinued around 2012 being an indication that irrigation schemes are not functional in the sub-Saharan region. The other cause for poor irrigation performance was the forceful removal of communities by the colonial regime. This resembles what happened during the Fast-Track Land Reform Programme of 2000 in Zimbabwe where some of the irrigable land was turned into villages. The communal sector became one of the main agricultural sectors in Zimbabwe as it covered about 41.4 % of total area of Zimbabwe. However, despite the considered agricultural contribution to the economy of the country, food

shortages continue to plague Zimbabwe. Agricultural production continued to miss targets since 2000 due to the controversial land reform programme.

Hunger in Zimbabwe was at a five-year high with one quarter of the rural population close to 2.2 million people facing food shortages (Mutambara *et al.*, 2014). Due to the el Nino-induced drought about 4.1 million people were to be food insecure at the peak of 2017 season (World Food Programme, 2017). This resulted in malnutrition in households, mostly in rural areas where maize was the staple food. Poor support to farmers was also cited as a contributory factor to food deficits and the need to import the staple grain (maize) annually. Makate *et al.* (2016) also found that smallholder farmers in Zimbabwe had little support from government and NGOs for good scheme productivity. The results of some evaluation studies carried out in Zimbabwe (FAO, 1999, 2010; AGRITEX, 2010), however, show that formal smallholder irrigation schemes continue to have low productivity and are evidently unsustainable. An estimated 120 000 ha is under irrigation of which 11 % is occupied by smallholder farmers (AGRITEX, 1999; 2010). In 2021about 70% of the country's irrigation schemes were revitalised (IFAD, 2021) and ZimVac (2012) indicates that 24 % of the wards in the country had irrigation schemes. Partially functioning schemes were at 38 % utilisation whilst 30 % of the irrigation schemes in some wards were not functional (ZimVac, 2014). Currently, 202 SIS have been developed and 82 are non-functional (ZimVac, 2022). A total of 220 000 land is under irrigation as spelt out in the IFAD (2021). An increase of 100 000 ha of land under irrigation was realised compared to120 000 ha as of 2010.

Nkabule & Dhlamini (2013) after studying Maplotini irrigation scheme in Swaziland concludes that the success rate of SIS was very low. The schemes have not contributed to improving the lives of smallholder farmers yet alone contributing to the economic growth of the country. Instead, there was land degradation caused by the farmers due to poor operations thereby negatively affecting the environment. The reasons for poor or low yields in production included limited knowledge, lack of training in business and financial management. Fanadzo *et al.* (2010) attribute the poor performance of small-scale irrigation schemes to the same factors. McCarty (2015) in a study in Ethiopia observes that trained smallholder maize farmers resorted to use of new seeds and improved types of fertilisers using the newly acquired skills that resulted in the realisation of higher yields. Increasing farmer productivity as much as it is important to Ethiopia is also a necessity in Zimbabwe's economy. This can only come true through smallholder farmer training (Rukuni, 2006; Nhundu & Mushunje, 2010; Scoones, 2013; Mutambara *et al.,* 2014). Most of the newly resettled farmers lacked the knowledge to

farm like the previous farmers. The government need to expand its research and extension services to impart knowledge to the new farmers. The knowledge, skills and attitudes of the farmers is then tested using the 3 domains of learning that forms the basis of every training session. The high yields obtained from irrigated land, coupled with other benefits such as increased food security, incomes, employment creation and drought relief savings are indications that irrigation schemes act as catalysts for better livelihoods in communities through poverty alleviation. Mutema irrigation scheme established in 1932 is testimony to this success story as schemes provides socio-economic benefits to both the community and the country at large as agricultural lands provide the primary means of livelihood and revenue sources for developing other sectors of the economy (Rukuni, 1986; Mupaso *et al.*, 2014).

It was critical to examine the learning domains as they are applied in the irrigation schemes by farmers for optimal maize output. This was a major contributory factor to the failure to meaningful production. Examination of the organisation and training methods were of fundamental value in assessing why these farmers were failing to maintain self-sustenance using all the resources available to them.

2.4 Zimbabwe's economic and agricultural policies

Zimbabwe introduced economic development policies in the first decade of independence (1980-1990) with the aim of developing the country through citizen participation in the development process. Growth with Equity introduced in 1981 focused on the need to address the inherited inequalities mainly through land redistribution. The allocated resources in the agricultural sector were used to transform and develop the rural peasant sector and to resettle communal farmers on commercial farms (GoZ, 1982; Mlambo, 1987). Irrigation schemes were developed in the rural areas to assist in the transition from purely subsistence economy to being major players in the country's economy thereby creating employment and poverty eradication. The Economic Structural Adjustment Programme (ESAP) implemented from 1991-1995 was introduced to pursue a free market-led economic development strategy (LEDRIZ, 2012). Emphasis was placed on strengthening the human capital base. Special training was initiated for skills acquisition for relevant areas for the development of the country including the agricultural sector to improve production. A successor to ESAP was the Zimbabwe Programme for Economic and Social Transformation (ZIMPREST), which came into place during the period 1996-2000 (GoZ, 1997). The policy aimed at pursuing economic empowerment and poverty alleviation by generating opportunities for employment. This was

to be achieved through the promotion of small-scale agriculture facilitated by research and extension services. The Fast-Track Land Reform Programme reduced the area developed for irrigation from 200,000 ha to approximately 120,000 ha. This move also caused some donor agencies to withdraw their assistance that resulted in reduced outputs due to difference in policies. One notable change that was brought about by the land reform programme was that the large-scale commercial irrigated areas came under the A1 and A2 schemes.

A Zimbabwe Agricultural Policy Framework (ZAPF), was introduced between 1995-2000 that focused on raising the incomes and standard of living of smallholder farming communities. . Also introduced was the Zimbabwe Agenda for Sustainable Socio-Economic Transformation (ZIM ASSET). Food and Nutrition Cluster's goals aimed at reducing household food insecurity from 25 % down to 2 % by 2018. The goals were to be achieved through increased cereal crop production and availability that included maize. The strategies used included timeous input support, training of smallholder farmers and infrastructure development of irrigation.

The Government of Zimbabwe (2012) and Nhundu *et al.,* (2010) in their comprehensive reports stated that the agricultural sector is faced with challenges such as low irrigation productivity and low level of farming skills amongst farmers resulting from lack of relevant training. Sectoral constraints included shortages of crop inputs such as fertilizer, poorly developed markets and inadequate investment in the rehabilitation and development of irrigation systems to combat the effect of recurrent droughts (Scoones, 2013). Most of the studies did not pay particular attention to the domains of learning of affected farmers.

2.5 Overview of agriculture and food status in Zimbabwe

Irrigation brings food security and income in households the world over. Zimbabwe's economy recorded real growth of 10 % per year in 2011 before it slowed down during the period 2012-2013 due to poor harvests. As spelt out in the Ruzivo Trust Factsheet, (2015) and GoZ, (2014), maize production was at 14%. Although maize is an important crop in the country, it has never reached the self-sufficiency level over the last 20 years.

The Maputo Declaration of 2003 (GoZ, 2012) recognised the importance of agriculture in economic development and encouraged governments to spend at least 10 % of the national budget towards agriculture. In response to the declaration, Zimbabwe in its Comprehensive Agricultural Policy Framework (2012-2032) aims at rehabilitating and modernising irrigation

schemes among other aspects. The objective being to ensure that all previously equipped irrigation areas are functional (GoZ, 2014). Deteriorating infrastructure for the marketing and movement of produce such as roads and telecommunications affects the agriculture sector. The GoZ also aims at providing adequate and timely funding for irrigation development through re-establishing the National Farm Irrigation Fund that was previously introduced in 2000 but had no takers (Rukuni, 2006; Scoones, 2013). Even the support offered by Food and Agricultural Organisation and GTZ in small-scale schemes together with the European Union went unused. Lack of efficient and effective support to agriculture need to be addressed as this restricts dissemination of productive farm technologies and commercial skills. The most important factor considered in this study was the element of agricultural education and training. The GoZ targets the training of all farmers to be realised through upgrading of modern teaching and training technologies that address agricultural knowledge and skill challenges or gaps in the farmers. The GoZ however, need to assess the how, where and when of the training and skills acquisition methods.

Food poverty experienced in Zimbabwe is attributed to depressed production due to droughts. Zhangazha (2014) highlights that poverty in rural areas had increased by 76 % from 63 % in 2013 as households failed to produce enough to meet their daily needs. The World Food programme as quoted by Zhangazha (2014) indicates that Zimbabwe was number 156 out of 187 countries in terms of food deficit with Sub-Saharan Africa having
23.2 % of undernourished population in the year 2016 (FAO, 2015). The poor support to farmers and inequality of land distribution are also contributory factors to food deficits and food insecurity. As a result, the country became a net food importer as indicated by the importation of 482 metric tons in four months from South Africa in 2014 through the Food Deficit Programme. The same happened during the 2018/2019 season. This was an indicator that the grain was not sufficient as Mukumbura Ward 4 only, about 1 900 people needed food aid. World Food Programme in 2014 reports that hunger in Zimbabwe was at a five-year high with one quarter of the rural population close to 2.2 million people facing food shortages (Mutambara *et al.,* 2014). Universal Declaration of Human Rights (1948) (Article 25) reflects that ”everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food…” (Sadza *et al.,* 2015:21). On page 22 the authors cited the African Charter on Human and People’s rights, 1987 that seeks to promote and protects human rights and basic freedom in Africa. Strategies used would include timeous input support, training of smallholder farmers and infrastructure development.

Nhundu & Mushunje (2010) carried out studies in Goromonzi District of Mashonaland East Province. They observed that there were no relevant training services offered to farmers. The GOZ (2014) alludes to the importance of irrigation to sustainable agricultural production and food security in the face of climate change. Zimbabwe had about 13 million people and of that 42 % is aged less than 15 years (ZIMSTAT, 2013). This strong demographic factor calls for the expansion and intensification of irrigated agriculture in the country to meet increased food demand and employment needs both in the medium to long term.

2.6 Human capital development in irrigation schemes

Human capital refers to the collective skills, knowledge, or other intangible assets of individuals that can be used to create economic value for the individuals, their employers, or their community. Education in the form of training is an investment in human capital that pays off in terms of higher productivity. Limited knowledge of cropping systems among farmers was a major constraint to improved crop productivity in smallholder irrigation schemes (Fanadzo *et al.,* 2010). The focus of this context is to relate the training undertaken by smallholder farmers with the mind capacity of the clientele through Bloom's taxonomies of learning domains. These taxonomies (cognitive, affective and psychomotor) are the three levels of the mind that drive people to learn coupled with pragmatism philosophy that espouses that ideas have value only when they work. Grassroots communities can work with government or development agencies to achieve sustainable development following principles that are of value to them. Farmers as adults (Freire, 1980; Nyerere, 1967; Sincero, 2011) are guided by these learning theories as they learn for a purpose and for immediate use and not education for banking. Manpower development and training is an important aspect of irrigated maize production. Training is very dynamic. Its elements cannot be left for long without the possibility of their becoming stagnant or outdated.

Knowledge is not static and new systems and techniques are continuously evolving. Effective training is essential for the successful adoption and use of new technologies in smallholder farming (Makate *et al*., 2016). Several studies have shown that training programmes that are tailored to the specific needs and constraints of smallholder farmers can significantly improve their knowledge and skills in the use of new technologies (Bezabih *et al.,* 2017; Wossen *et al.,* 2017).

2.7 The Learning Domains Theory and its Application

Knowledge in the agricultural context is noted as the acquisition of analytical and critical thinking skills, where a person can make own decisions. That same person should be able to familiarise self with specific and relevant agricultural activities with a better understanding based on the three basic domains of human learning by Bloom (Randall, 2011). These are the *cognitive* (theoretical or intellectual), *affective* (humanistic) and *psychomotor* (manipulative or skill development). Knowledge, Attitude and Skills (KAS) are taxonomies of learning behaviours that form the basis of achieving the goals of the training process. The learner should acquire a new skill, knowledge and or attitude after learning. Learning domains are the basic reference for all learning situations worldwide. Emphasis historically was put on the lowest level which is the knowledge. This is the cognitive that deals with recall or knowledge of the development of intellectual skills and abilities (Bloom, 1956; Anderson & Sosniak, 1994). These domains co-exist as each domain depends on the other for a successful human capital development. The rationale for developing extension services in countries is driven by the desire for the enhancement of farmer human capital. The importance of learning domains is provision of structured planning, designing, assessment and evaluation of training and learning effectiveness. As such they work as a checklist to ensure that training planned can deliver and achieve intended results.

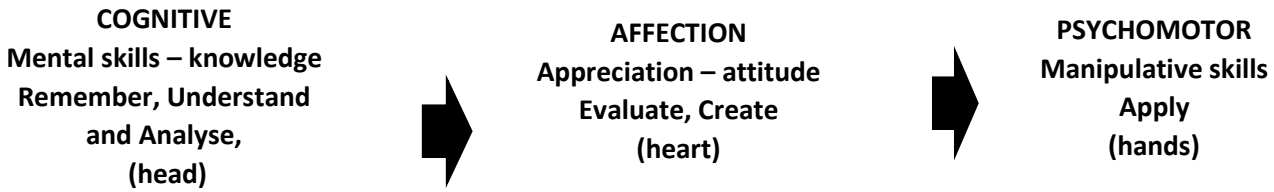


Figure 2.1: Bloom's Taxonomy of Learning Domains

Figure 2.1 depicts that farmers in the three chosen SIS were evaluated to assess whether the production gaps that exist between the actual and potential output has been reduced due to training received. This was measured in terms of participation, outcomes and impacts. The effectiveness of traditional agricultural approaches that were introduced around 1930s and the newly introduced post-independence approaches were examined. Focus was on the establishment of the effectiveness of the training sessions in terms of comprehension, change in attitudes and applying the learnt techniques. Domains aim at producing a self-actualised farmer who can make own decisions, adapt and adopt and being able to monitor and maintain the schemes' operations without waiting for the government or the donor. Using this approach to the study enabled the research to come up with the proposed improved training approach framework with the assistance of the farmers as they made own decisions through assessing the current training approaches' successes and failures.

a) Cognitive domain

There are various abilities or skills that belong to the *cognitive* domain which is a psychological process. These include how to make decisions and problem solving, formation of beliefs and attitudes as well as the ability to use the existing knowledge for establishing criteria for learning and training situations. Knowledge, comprehension and analysis collectively define the cognitive domain, which is centred on using mental skills (Clark, 2015). All activities start from the mind that is the knowledge base of information (Ndhlovu, 2013). The domain deals with information recalling and mastery of subject matter during and after learning session (Businessballs, 2017).

b) Affective domain

Phillips (2009) and Anderson & Krathwohl (2010) are of the view that *affective* domain participants in any learning situation are expected to change attitudes, values and appreciation. This implies that the affective domain focuses on the manner in that people deal with things emotionally. One acts consistently based on personal beliefs and values and these will be well organised. Value is attached to the newly acquired information and one responds actively to an activity.

c) Psychomotor domain

The *psychomotor* domain encompasses manipulative performance or actions. Skills are developed during training and improved gradually as the recipients of training repeatedly apply new behaviour in life. Through practice skills are developed with precision, procedures or techniques in the execution of the task (Anderson & Krathwohl, 2010; Randall, 2011; Ndlovu, 2013). The psychomotor domain has various stages starting with hands, legs and eyes for manipulative skills. Even the illiterate is easily trained when this domain is practiced to any age group. Both the cognitive and psychomotor domains are combined for better articulation of the problem at hand.

Bloom's taxonomy is a reference for all teaching and learning situations. It acts as a checklist for proper planning and implementation of intended programmes. The three domains of learning explained above anchor this study that was designed to examine how farmers involved in irrigated maize farming exercise the domains to get better yields through irrigation farming than dry land farming.

2.8 Communication for innovation

The term extension's meaning is not well understood although it has been accepted and used by people in extension institutions. However, extension has no universal working definition that best describes the process (Hawkins *et al.*, 1982). In the modern-day agriculture, it is known as communication for innovation. It is stated that extension is the provision of technical information for production to farmers to help them analyse and make alternatives to farming decisions. The teachings aim at improving farming practices and adoption levels. Furthermore, agricultural extension is a method of teaching the rural folk to develop skills for better farming through well planned programmes to help them solve agricultural production problems. Extension has a mandate to ensure that expected benefits are achieved from the investment done in agricultural research (Chauhan, 2007). Most governments' role, therefore, is to guard the quality of outputs for the good of the general populace with the aim of changing the well-being of the farmer. Ferroni & Zhou (2012) highlights that gaps in knowledge contribute to creation of yield gaps.

Communication for innovation has various channels of passing on the message to the targeted audience (Chauhan, 2007; bendra Jha, 2018). These include radio, television, telephone, meetings, informal talking, books, exhibitions, bulletins, posters, newspapers and leaflets. Communication has its place in each development process, be it social, economic, political

and educational. Figure 2.2 depicts the process of extension and the aims of the whole activity to further define agricultural extension. The essence of the philosophy (Figure 2.2) is that the programmes are decided by participants as they identify the gaps to be filled by the education. Participation in extension programmes is voluntary as it is needs based.

2.8.1 Sustainable Livelihood Framework

The sustainable livelihood framework provides a structure for holistic poverty eradication action. The approach aims at finding ways to the problems faced by communities. Emphasis is on creating human-centred, responsive and participatory development opportunities. The framework is a powerful tool for understanding and addressing poverty in vulnerable communities (Serrati, 2008).

SLF is not a theory but a framework that is applied fieldwork. It aims at taking the last first as it values local knowledge (Natarajan *et al*. 2022). The framework calls for a new style appraisal policy that advocates shift from imposed prescriptions to context specific approaches that allows communities to reveal and find their ground in the policy framework. Thus the approach facilitates identification of practical priorities for actions that are based on the views and interests of those concerned. Needs assessment initiatives helps in identifying the gaps in societies that are then used for capacity building (Neef, 1994). Their potential can be easily realized in terms of skills, social networks and access to physical and financial resources. Just like the philosophy of extension the aim is to get improved food security and human dignity thus fulfilling the inner needs as postulated by Neef (1994).

The approach is a complimentary technique and does not replace other developmental tools. It seeks to empower individuals through realization of their potential for a positive change. Although SLF is not a method it strengthens certain methods like Rapid Rural Appraisal (RRA) and Participatory Learning and Action (PLA) (Natarajan, 2022). These methods are vital in the irrigated maize farmers as they need hands on in their fieldwork. The smallholder farmers benefit from sustainable practices, diversified crops and improved access to markets. Included is also knowledge on agro-forestry, organic farming and community seed banks to enhance resilience.

Certainly, the agricultural extension method and the sustainable livelihood framework work for the same cause of trying to better community livelihoods. Application of Bloom's domains of learning enables facilitators and policy makers to have successful programs. The cognitive,

affective and psychomotor skills of concerned participants are assessed thus providing a better teaching and learning environment. All teachings are based on these three levels of the mind, hence the justification of using Bloom's theory over others. All other approaches and theories compliment or feed into the domains of learning.

Strengths of frameworks lie in its adaptability by communities. Adoption is based on the proper program implementation first by needs assessment and comprehension of taught material. This is achieved through cognitive, affective and psychomotor domains. This, allows policymakers to tailor inventions to meet specific contexts considering local needs and aspirations.

2.9 Identification of the key learning domains for effective use of irrigation technologies in smallholder maize farming in Mashonaland Central Province

2.9.1 Purpose of agricultural training

New systems and techniques are continuously evolving hence the need for capacity building of farmers for improved performance of small-scale irrigation. Mudombi (2013) concurs that there is need to further train these farmers as smallholder farming sector is facing challenges of skills deficit and lack of information pertaining to market links that results in perishables being wasted. Non-governmental organisations used the SLF in the fight against poverty. This was a strategy for the poorest to strive to generate income to purchase food, shelter and clothing among other poverty indicators (Binala, 2016). Maslow (1943) propounds that the main purpose would be to meet the physiological, spiritual and economic needs of everyday life. This has been the aim of agricultural development in areas of better cropping practices due to the ever-changing technological development to achieve self-sufficiency in households to meet the ever-growing demand of maize in the Zimbabwean communities.

Philosophy of Extension

WHAT OUGHT TO BE (The ideal view of life)
(What the people should or could be because of the extension program/activities expressed in objectives)

The Gap (the problem area or needs of the people)

How to bridge the gap (educational means to attain the objectives- methods, procedure used relation to needs of the people that must be addressed by extension)

WHAT IS
The present state of the people/client in terms of knowledge, skills and attitudes they possess: their resources, present level of living, and others.

Figure 2.2: Philosophy of Extension (Source: Adapted from Magcawas, 2016)

2.9.2 Type of training currently offered

Sub-Saharan Africa, including Zimbabwe, relies heavily on agriculture as a form of employment, foreign currency earner, and forms the bulk of gross domestic product (Chivuraise *et al.,* 2016). There is an increased recognition in the agricultural sector to groom farmers to become self-efficacy through problem solving, innovators and become constructors of new knowledge using farmer-extension–research linkages (Sewell *et al.*, 2017). Knowledge gained through various trainings can be used to tackle the problem of non-performance in the irrigation schemes they operate from. The Ministry of Agriculture, Mechanisation and Irrigation Development (MoAMID) through the Department of AGRITEX aims at providing effective and efficient agricultural extension knowledge to various clientele in the area of agronomy. The aims include the following tabulated aspects among others as adapted from the MoAMID Report of 2018.

a) Conduct on-farm trials and demonstrations to verify research results as well as promote technology adoption.
b) Synthesize research recommendations and feed from on-farm work into extension packages for use by field officers.
c) Conduct on-farm trials and demonstrations to verify research results as well as promote technology adoption.
d) Synthesize research recommendations and feed from on-farm work into extension packages for use by field officers.
e) Extension material in the form of advisory notes, fact sheets, fliers and for staff and farmers.
f) Identify technical deficiencies and the impact of adopted technologies through surveys, observations, reports and visits.
g) Compile and revise resource training manuals.
h) Train field officers on all obligatory and other courses as and when need arise.
i) Establish and develop collaborative links with research stations and other stakeholders (fertiliser, chemical companies and commodity associations).
j) Support knowledge and skills dissemination by attending and participating at field days and shows.
k) Attend to queries from officers and farmers relating to crops.
l) Competition and show judging at both provincial and national levels.

Apart from offering cropping knowledge, ARDAS also offers training and information that is the core of this study. In its 2018 report, MoAMID indicated that the wing's responsibility was curriculum development, training needs analysis, coordination of the Master Farmer Training programme with the responsibility for its co-ordination, monitoring and evaluation services. The Department of ARDAS is mandated with the training of personnel both internally and externally. This includes farmer training with the aid of audio visuals that contribute to the effectiveness of the training sessions. There are radio and television programmes that are aired at scheduled times like Talking Farming, `*Murimi Wanhasi*` and Eco-farmer. However, these are a challenge to most rural farmers as some do not possess the gadgets to be able to listen to the aired programmes.

2.9.3 Effectiveness of agricultural training

Social change in communities is realised through collaboration between smallholder farmers and the government or developmental agencies. The partners should be led by community development principles spelt as: *Empowerment, Participation*, *Partnership* and *Self-determination*. This dwells on the support to people to make their informed decisions and choices (CDAS, 2018). Communities are encouraged to come together to make decisions of what they want and how to achieve the desired goal (Sewell *et al.*, 2017). The training programmes are determined by the needs of the community, therefore, needs assessment is mandatory to avoid duplication of projects or those approaches that have already failed to yield results.

Several studies have highlighted the importance of effective training interventions that focus on improving farmers' knowledge and skills in irrigated maize farming. In Zimbabwe, research has shown that training interventions that are designed to address specific farmer needs can lead to improved yields and increased incomes (Kamwi, 2019). Such interventions can be delivered through a range of methods, including the use of demonstration plots, farmer-to-farmer learning, and on-farm visits and field visits. Establishment of FFS, mobile extension services and the use of information and communication technologies can also be introduced to improve extension services (Mhlanga *et al.,* 2020).

Contribution of agricultural extension methods can be assessed qualitatively by looking at the improvement of livelihoods of the affected community. This even stretches to the outward

look of pets such as dogs in a farming community. Lukuya *et al.* (2012) highlights that Kaufman & Keller (1994) developed a framework for training assessment. The four dimensions had to do with relevance of the training programme to the participants; participant learning attributes in terms of knowledge, skills and attitude; the transfer of learning on farming activities and the results out of improved production and efficiency.

To enhance the effectiveness of training interventions, it is important to tailor them to the specific needs and challenges faced by smallholder farmers engaged in irrigated maize farming. One study in Zimbabwe found that training programmes that were developed with input from farmers themselves were more effective in improving their knowledge and skills, as well as their adoption of improved agricultural practices (Makate *et al.,* 2016). A survey by Jona & Terblanche´ (2015) in Namibia, farmers rated lowly the adequacy of the training offered. The major problem cited was of the top-down approach on the introduction of training programmes.

The interventions have been shown to improve farmers' knowledge and skills in a range of areas, including soil fertility management, water management, and pest and disease control (Kamwi, 2019). Irrigated maize farmers need to be taught techniques, such as water conservation. Farmer groups in Kenya were trained to build new ridges for capturing water. Knowledge on drought-tolerant crops was also imparted to farmers (Makoye, 2013). Historically this information was only made available to large-scale white commercial farmers in Zimbabwe. The training approaches that were introduced by Alvord in 1927 and the continuous review of the system up to date warrant a re-evaluation to assess their effectiveness in current agricultural practices. Overall, the effectiveness of training of smallholder farmers involved in irrigated maize farming can be assessed based on a combination of knowledge acquisition, adoption of recommended practices, productivity and profitability, sustainability of outcomes, and satisfaction and engagement of the farmers.

2.9.4 Indicators of adequacy of agricultural training

Effective training interventions can lead to improved knowledge and skills, and ultimately better crop yields, incomes, and food security. In Zimbabwe, research has shown that training interventions that focus on developing farmers' practical skills and knowledge are more effective in promoting sustainable agriculture practices than those that focus on theoretical knowledge only (Manyena *et al.,* 2015).

Agriculture is a means of reducing malnutrition in the nutritionally vulnerable population especially children, women and the elderly (Jona and Terblanche´, 2015; Gondwe *et al.,* 2017). The mitigatory measure to curb malnutrition is done through ensuring that families realise food variations that are readily available and accessible. Dietary diversity is normally based on the level of literacy of the mother and level of nutritional training.

Proper agronomic training plays an important role in agricultural development and transformation resulting in heightened cereal yield (Yadav *et al.,* 2013, Gondwe *et al.*, 2017). Gondwe *et al.* (2017), reports that 70 % of the Zambian population were into agriculture that includes urban farming. It was however, noted that food shortages were high as evidenced by the levels of malnutrition that was at 48.3 % in below 5-year children and lack of diet diversity that were reported by the Food and Agriculture Organisation for the same country. In India the number of people who failed to access food remained high as noted by Panneerselvam *et al.* (2010). In Zimbabwe, the rural communities rely on food handouts from the donor community or government as a measure of reducing hunger in households.

Farmer training programmes are said to be adequate if there is relative change from the old practices that results in participants managing to transform their lifestyle. In Zambia, Gondwe *et al.,* (2017), highlights that most farmers who were trained in various agricultural practices demonstrated good knowledge and carried out activities skilfully. Over 93 % of the farmer participants were happy with the training received and had changed their agronomic practices. Results of the adequacy of agricultural training should be observable by a reflection of the attainment of the four dimensions of food security (Burlingame, 2011; Mbwana *et al.,* 2016).

It is important to develop appropriate training content that considers the needs and challenges of smallholder farmers in Zimbabwe. The development of training materials and methodologies that incorporate local knowledge and practices can be beneficial in promoting the adoption of improved practices (Mashingaidze *et al.,* 2016). Furthermore, the training interventions need to be in a format that is accessible to the target audience, which in Zimbabwe may include people who are not literate in English. A key challenge in the implementation of training interventions is the limited availability of extension workers in rural areas. The limited number of extension workers often results in poor quality of services and inadequate coverage of farmers. One approach to addressing this challenge is the use of ICTs, which can be used to deliver training and extension services to farmers, even in remote

areas (Mhlanga *et al.,* 2020). Mobile phones have been used to disseminate agricultural information to farmers in Zimbabwe and have been found to be an effective tool for promoting agricultural development.

2.9.5 Importance of training needs assessment

One study in Zimbabwe found that training programmes that were developed with input from farmers themselves were more effective in improving their knowledge and skills, as well as their adoption of improved agricultural practices (Makate *et al.,* 2016).

Training Needs Assessment (TNA) can be carried out in various ways as means of fulfilling the main goal of determining how best to use the limited resources available (Thompson, 2017). The most important factor is the decision on the needs to be prioritised first. An elaboration of a need that indicates that it is the way things are and the way they should be is necessary. Needs analysis uncovers multiple needs but these must be placed in order of preference and greatest needs depending on the criticality and consequences of the need. If analysis is not done organisations and developmental agents run the risk of training wrong people at the wrong time with the wrong content that is a waste of time, energy and resources for all stakeholders. Uncovering of reasons why other projects failed in the area should be facilitated so that organisations avoid the same problems or pitfalls that hampered progress of previous projects (Nadler & Nadler, 1994). Needs assessment is an important aspect in initiating developmental projects that are successful in community development through improved decision making.

When designing training programmes for smallholder farmers the cultural and socio-economic context in which they operate should be considered. For instance, research has shown that gender dynamics can play a crucial role in shaping farmer adoption of new technologies (Mujeyi *et al.,* 2017). It is essential to develop training programmes that are tailored to the specific needs and preferences of different farmer groups. Additionally, training programmes should be designed to enhance the social capital of farmers, as this has been shown to be an important factor in improving the uptake of new technologies (Abate *et al.,* 2012).

2.9.6 Selection and organisation of smallholder farmers for agricultural training

Farmers are principal agents for sustainable agricultural production. Farmer learning should, therefore, be enhanced to help improve their production capacity given the challenges posed by climate change that is causing food insecurity with Zimbabwe being not spared. In western

Kenya (Lukuya *et al.*, 2012), the farmer trainer approach has been used for more than ten years where farmers are voluntarily trained. Experiments were undertaken and the lead farmers shared their knowledge and experiences with their counterparts. The advantage of the approach was the wide coverage and ability to reach large numbers of farmers (Christoplos, 2010). Since it was peer to peer education, chances of acceptance by other farmers were high considering that the volunteer farmer trainers spoke the same language and was one of them..

Lukuya *et al.* (2012) reveal that farmers in their study volunteered to be trainers of their peers. Formed farmer groups were trained with the others following as there are always early adopters, late adopters and laggards in developmental programmes. Meetings with the farmers informing them about the new projects to be implemented were set up by EOs. The participation rates of men and women varied in all the farmer groups. In Zimbabwe as spelt out in MoAMID (2014) farmers in the irrigation schemes received Training of the Trainers (ToT) just like the farmer trainers in Kenya as stated by Lukuya *et al.* (2015). This helps in covering up the gap that is left with the extension officer-farmer ratio that exists in the country as farmers train each other and share knowledge and experiences.

Challenges of transportation had been experienced ever since in most developing countries. This same problem was experienced in Kenya where farmer trainers used their own means to travel to training areas. The advantage of these localised trainings was that farmers would debate on topics they need covered. In the same vein the visits to other irrigation schemes that they do triggers the need to learn more. Farmers in the irrigated maize schemes were simply trained as groups with no age and gender differentiation. This could pose as barriers to training in cultures where men and women do not mix or undertake tasks together. Mujeyi *et al.* (2017) concurs that when designing training programmes for smallholder farmers there should be consideration of the cultural and socio-economic context of the areas. Gender dynamics can play a major role in shaping farmer adoption of new technologies. The vulnerable groups, women are left out in most activities. Additionally, in other cases some individuals are not comfortable to train together with their husbands or children, this form of organisation would be a barrier to effective training. However, having mentioned that, it is to the advantage of older people to be trained without segregation. Older farmer trainees benefit from informal and appropriate training at the right time and place (Zwick, 2015) that makes training insensitive to age. Those youngsters would help explain complex topics to the elderly farmers.

When designing training programmes, extension officers should consider time flexibility as older participants might shun the training session because of their daily routines. HIV/AIDS pandemic has seen some female farmers or males in very few cases, looking after invalids who have scheduled times for medication or elderly people. Of interest are meetings such as the Command Agriculture/Presidential Input Scheme meetings that cause participants to shun trainings. The low attendance is compounded by the declining of voluntary learning associated with age that makes older farmers have low interest in training (Zwick, 2015). Hence the emphasis on flexibility and the right content to be delivered in the appropriate mode that suit the cognitive, affective and psychomotor domains in the trainees.

Questions like, were instructional materials used proper or suitable for adult learners and was the training relevant to the targeted group always arise? Adults want to learn at their own pace when they see the benefits of education (Freire, 1980; Nyerere, 1967).

2.10 Improved learning domain-based framework for training farmers in irrigated maize farming

Smallholder farmers in Zimbabwe face many challenges in adopting new agricultural technologies and practices, which may limit their productivity and income. To address these challenges, there is a need for improved training programmes that provide farmers with the knowledge and skills they need to succeed. A learning domain-based approach is one potential solution that can help to address this need.

An improved learning domain-based framework for training farmers in irrigated maize farming could be developed through collaboration with farmers and other stakeholders. This framework would be designed to address the specific needs and challenges of smallholder farmers in Zimbabwe and would be tailored to their individual learning needs. The framework would be based on the principles of adult learning and would include a range of activities such as group discussions, field demonstrations, and practical exercises.

To improve this framework, it would be necessary to first assess the current level of knowledge and skills of smallholder farmers in irrigated maize farming. This would involve conducting a needs assessment and using the results to inform the design of the training program. The training program would be designed to address the identified gaps in knowledge and skills,

and to build on the existing knowledge of farmers. A range of delivery methods, such as on-farm training, classroom-based training, and online training could be used. The approach would be tailored to the individual learning needs of the farmers and would be designed to be flexible and responsive to changing needs and circumstances. The program would be designed to promote continuous learning and improvement and would be supported by ongoing monitoring and evaluation to ensure its effectiveness.

Overall, an improved learning domain-based framework for training farmers in irrigated maize farming has the potential to improve the productivity and income of smallholder farmers in Zimbabwe. By providing farmers with the knowledge and skills they need to succeed, this framework could help to support sustainable and inclusive agricultural development in the country.

2.10.1 Components and Characteristics of improved learning domain-based framework for training farmers in irrigated maize farming

The improved learning domain-based framework for training farmers in irrigated maize farming is composed of different components and characterised by specific features that can be used to enhance the training of farmers. One of the components of the framework is the development of learning modules that provide farmers with the knowledge and skills needed for improved maize production. These modules should be designed to be interactive, practical, and easy to understand. The modules will be developed with the aim of addressing the specific needs and challenges faced by farmers in Mashonaland Central Province of Zimbabwe.

Another component of the framework is the use of experiential learning methods. The experiential learning approach will enable farmers to learn by doing, which is more effective than simply reading or listening. The experiential learning methods will be used to provide farmers with hands-on training in all aspects of irrigated maize farming. This approach will enable the farmers to gain practical skills, which will be immediately applicable in their farming activities. The framework will also include the use of peer-to-peer learning. Peer-to-peer learning involves farmers learning from each other, sharing their experiences, and supporting each other in their farming activities. This approach is particularly useful in rural communities where farmers face similar challenges and can learn from each other's successes and failures. Peer-to-peer learning will be facilitated by the formation of farmer groups that will be encouraged to share knowledge and skills and support each other.

The use of extension services will also be involved in the framework. Extension services will provide farmers with information and guidance on the latest technologies and practices in irrigated maize farming. The extension services will be delivered by trained extension officers who will work with farmers to identify their specific needs and provide them with the necessary support.

Finally, the framework will incorporate the use of mobile technology. The use of mobile technology will enable farmers to access information on-demand and communicate with extension officers and other farmers. Mobile technology will also be used to provide farmers with real-time weather information, which is critical for planning and decision-making in irrigated maize farming.

In summary, the improved learning domain-based framework for training farmers in irrigated maize farming is characterised by the development of interactive and practical learning modules, the use of experiential learning methods, peer-to-peer learning, extension services, and the use of mobile technology. The framework is designed to address the specific needs and challenges faced by farmers in Mashonaland Central Province of Zimbabwe and provide them with the knowledge and skills needed for improved maize production.

Overall, an improved learning domain-based framework for training smallholder farmers in irrigated maize farming should incorporate a range of components and characteristics to ensure that the training is effective, relevant, and sustainable, and that it promotes the development of the farmers' skills and knowledge over the long term.

2.11 Evaluation of the impact of the developed training approach on the productivity and income of smallholder maize farmers

The early introduced agricultural extension approaches were mainly concerned with the transfer of technology (Pyburn & Woodhill, 2014). Technology transfer aimed at passing on research findings through extension officers to farmers who were considered as empty vessels. The introduced approach was basically a one-way flow as these research findings were from the West.

Several criteria have been used to assess the effectiveness of training of smallholder farmers involved in irrigated maize farming. One of the major criteria is the level of knowledge gained

by the farmers because of the training. Studies have shown that training programmes that incorporate various learning domains, such as cognitive, affective, and psychomotor, result in greater knowledge acquisition among smallholder farmers (Luo *et al.,* 2018; Gbandi & Sallah, 2019).

Another important criterion is the level of adoption of new farming practices or technologies introduced during the training. This can be evaluated by measuring the percentage of farmers who have adopted the new practices or technologies and assessing the extent to which they have integrated them into their farming practices. Smallholder farmers who received training on the use of improved seeds and fertilizers had higher adoption rates of these inputs, leading to improved crop yields. A study by Ndlovu *et al.* (2019) found that training programmes that focus on practical, hands-on activities and use demonstration plots for learning resulted in higher rates of adoption of recommended practices among smallholder farmers involved in irrigated maize farming.

The impact of training on the productivity and profitability of smallholder farmers is also a key criterion for assessing its effectiveness. A study by Masikati *et al.* (2017) found that training programmes that combine technical knowledge with business management skills result in increased productivity and profitability among smallholder farmers involved in irrigated maize farming. In Namibia, several organisations provided support services to farmers as a way of improving their livelihoods. It was not only in Namibia where the livelihoods approaches were initiated. The UK Department for International Development (DFID) focused its attention on the Sustainable Livelihoods Approaches (SLA) that aimed at eradicating poverty and hunger in communities through improved production and increased income. Agricultural productivity in Namibia (Jona &Terblanche´, 2015) increased mainly due to advisory services introduced around 1960s and 1970s. It is noted that these agricultural extension methods were largely centralised and detached from the rural folk. The same situation was observed in Zimbabwe during the colonial period. The agricultural extension system mostly concentrated on the large-scale commercial farms with the rural communities being neglected. This situation is observed in most developing countries where the agricultural system is normally a top-down approach with implementers only concerned with the provision of new information.

The sustainability of the training outcomes is another important criterion for assessing the effectiveness of training programmes. A study by Bingen and Sanginga (2019) found that training programmes that involve regular follow-up visits and reinforcement of learned

concepts over an extended period result in sustained improvements in the knowledge, attitudes, and practices of smallholder farmers.

Finally, the level of satisfaction and engagement of the smallholder farmers with the training program is an important criterion for assessing its effectiveness. A study by Chipindu *et al.* (2018) found that training programmes that incorporate participatory learning methods and involve the active participation of farmers in the design and implementation of the training are more likely to result in high levels of satisfaction and engagement among smallholder farmers. The major problem realised was that the research linkage and communication was poor as the organisations were not working in consultation with the affected communities.

2.11.1 Community participation in designing and implementation of developmental projects

The need to involve people in designing any community projects and issues that affect their health and behaviour has been advocated for by many humanistic philosophers. This is supported by the participatory appraisal method to try and explain why farmers should be involved in deciding on the appropriate approach and programme. If any success must be registered in the community development projects such as the peri-urban agriculture in particular irrigation scheme, people must understand from the inception of the project, what is expected of them, donor expectations and the benefits to be gained. All stakeholders, therefore, need to be involved so that they team up in owning the project, and decision making will not be a prerogative of a few influential persons.

The aim of participation is to achieve a special kind of power that belongs to the oppressed and exploited classes and groups and their organisations and defending their just interests to enable them to advance towards shared goals of change within a participatory framework. During the 1970s the many failures of top-down export designed development projects and programmes made people realise that effective participation is a critical success factor in development planning and implementation. Communities manages own development through people volunteering their time rather than through facilitation by an agent. The donor agent is only there to kick start the project and everything else is left to the jurisdiction of beneficiaries. The initiating and deliberations on projects is left to citizens so that they shape their common destiny. Teamwork is a vital element if any group is to be successful. Voluntary participation

by farmers enables achievement of SDG-1 `eradicate extreme poverty and hunger' as participants are goal-oriented learners.

2.11.2 Assessment of current training approaches for irrigated maize farmers

2.11.2.1 Farmer training frameworks initiated

There are three methods of Agricultural extension services that are common in Zimbabwe. These include Group extension, Mass media and Individual method of extension.

a) **Group methods of extension**

This form of extension method has been widely used over the past decade. The approach has less cost in terms of time and extension resources than individual methods as it reaches many people at the same time just like mass media communication. There is no concentration on individuals which can cause other farmers to be left out as the EOs concentrate on progressive farmers. The advantage of this method is that it is done in a favourable learning environment suitable for all gender and classes of smallholder farmers (FAO, 2015). The EO should consult IMC leadership before calling for group meetings. This is to curb shunning of trainings or meetings by smallholder farmers in subsequent callings if the meetings are deemed to be useless (Mika & Mudzimiri 2012). The methods include Master Farmer Training, Farmer Field Schools, Agricultural Shows, Field Days, Demonstrations and Commodity Groups. Of the listed approaches MFT, FFS and TV&S were traditional methods that were used by Agricultural Extension Officers.

b) **Mass Media Extension**

The channel reaches large numbers of people at the same time. It has the advantage of high speed and low cost to convey messages to millions of people over a wide geographical area making it cheaper to provide information to millions of smallholder farmer listeners (FAO, 2015).

The challenge with this form of extension is that it has no two-way communication. Extension Officers cannot provide advice, offer practical skills or answer questions immediately. This is an indication that the method is not suited for all tasks. For effective mass media extension service, EOs needs the experience and skills to convey the information on aired programmes understandably (FAO, 2015). Others can support the service through provision of relevant

information of creating posters and leaflets. In turn farmers need to have access to the medium which poses as a barrier since most rural farmers do not have radios or televisions. These are some of the principles of mass media extension services. Producers need to carry out needs assessment into current farmer knowledge, attitudes, practices and farming problems. Means of communication are through audio and print media. The radio listening group approach is widely used in Zimbabwe and other developing countries. Radio listening group (RLG) approach was tested in Chimhanda. Farmers were gathered in groups to listen to radio programmes addressing specific topics. Through participation, farmers discuss extension issues and share experiences and help each other to clearly understand the conveyed messages. The approach helps farmers to know what other farmers are doing elsewhere. It has low costs but has the disadvantage of being one-way communication. In Zimbabwe programmes were introduced by Econet a cellular company that introduced `*Murimi waNhasi",* Eco-farmer. The programmes were aired on set dates. The disadvantage is that some areas do not have transmitters. Like in Chimhanda they were listening to Radio Mozambique.

c) **Individual methods of extension**

In the developed and developing countries, face-face or individual methods are the widely used communication systems. This involves farm and home visits by EOs for informal meetings to provide farming advice. The aspect is the most important part of all extension work as it builds agent-farmer confidence. The purpose of such meetings should be clearly spelt out (FAO, 2015). It has the advantage of getting feedback instantly.

The following approaches were also initiated and had their own challenges.

d) **Group development approach**

The approach was used around 1960s to 1970s when many group development areas (GDAs) were established (FAO, 2015). The approach focussed on area and project development through community participation. Communities provided labour while the government and donors provided the necessary inputs. The concept facilitated extension services to be implemented in difficult areas. It was difficult for communities to depart from their way of doing things. The disadvantage of this approach was the top-down model such that services could not be directed to the needy. This created donor-government syndrome that made projects vulnerable if funders pulled out of the area.

e) **Farming Systems Research and Extension**

The approach is problem centred and emphasises on-farm trials as linkages among farmers, researchers and extension workers (FAO, 2015). The good part of the method is that it focuses on smallholder farmers. The challenge was that it was extractive than participatory resulting in its failure. This method is still on course by private companies and NGOs.

Overall, the training approaches are determined by the needs of the community. The approaches used would help in the establishment of the level of knowledge, change in attitude and application of skills by smallholder farmers.

2.12 Assessment of effectiveness of the developed training approach in improving the knowledge and skills of smallholder farmers in the use of irrigation technologies for maize farming.

2.12.1 Expected agricultural skills in irrigated maize farmers

The level of skills of smallholder farmers is an important factor that influences their productivity and efficiency in irrigated maize farming. Several studies have found that the level of skills possessed by farmers in Zimbabwe and other African countries is generally low and needs to be improved to enhance their productivity (Mhlanga *et al.,* 2018). To have equitable outputs from the irrigation schemes worldwide, tasks performed need improved knowledge and skills. The use of learning domain-based training approaches can be beneficial in improving the level of skills among smallholder farmers involved in irrigated maize farming. Such approaches can be designed to provide farmers with practical skills and knowledge related to maize production, as well as to improve their socio-emotional skills. By incorporating the principles of adult learning, such training approaches can be designed to be learner-centred, interactive, and participatory, which can increase the effectiveness of the training programmes (Mugwira *et al*., 2020).Cognitive and psychomotor domains are linked to produce meaningful results. Smallholder farmers using the mental recall processes are expected to read the materials to with understanding and to be aware of safe working practices with herbicides as they carry out their activities. There are outcomes that are expected such as individual learning and transfer of learning to the job in human resource development (Bransford, 2000; Miiro *et al.*, 2013). Improved performance, productivity and product quality enhancement should show the new knowledge and skills acquisition level. It was, therefore, the aim of this study to assess

if the trained farmers were using the newly acquired skills. If yes, then farmers should be able to grow enough so as not to go hungry and earn enough money to be on their own feet. If communities can fend for themselves, then, the product of learning has been realised.

Mwendera & Chilonda (2013) are of the view that if rehabilitation of the schemes is focused without developing human capital, it would yield little benefit. This entails both farmer and extension worker further training. Dossah *et al.* (2003) and Binala (2016) concur that for improved and effective management of the irrigation schemes both farmers and extension workers must be retrained to get optimum yields in the irrigated maize farming in Mashonaland Central Province. The effectiveness of a training session is normally based on how the delivery influences the participants. Extension workers should be well equipped and capacitated to be able to deliver the information to farmers for adoption and adaptation.
The assumption of training (Keita *et al.,* 2009; Millennium Challenge Corporation, 2014) is that farmers would move from subsistence to profitable commercial farming. This then defines the aspect of training in that it ensures the ability to transfer what was learned in one context to new contexts resulting in additional income and increase in high value-added crop cultivation. Higher yields with low production costs and improved access to new markets are realised. This is best achieved if farmers adopt the new practices at the right time. The level of skills of farmers involved in irrigated maize farming is critical in determining their capacity and performance. The provision of education and training programmes is essential in equipping smallholder farmers with the necessary knowledge and skills to improve their productivity and income. Contrary to the need of skills requisition, smallholder farmers often lack access to education and training opportunities, leading to limited skills and knowledge on sustainable farming practice. As a result, the application of appropriate irrigation technologies, use of quality inputs, and adoption of modern farming techniques is hindered, leading to low productivity and income.

The skills and knowledge of farmers in Zimbabwe on sustainable farming practices, soil conservation, and crop management have been found to be inadequate, leading to low crop productivity. Furthermore, smallholder farmers in Zimbabwe have been reported to lack the necessary skills on climate-smart agriculture practices, which could result in low resilience to climate change (Murwira, *et al.,* 2016). For smallholder farmers, learning takes place through informal and non-formal methods such as observation, imitation, and trial and error. However, these methods do not always provide the necessary skills needed to carry out farming

practices effectively, especially for complex tasks such as irrigated maize farming (Murwira *et al.,* 2016).

The level of skills among smallholder farmers involved in irrigated maize farming can also be affected by factors such as age, education, and gender. Older farmers who have limited formal education are likely to have lower levels of skills compared to younger and more educated farmers. Women farmers, who often have limited access to education and training, may also have lower levels of skills compared to their male counterparts (Murwira *et al.,* 2016).Improving the level of skills among smallholder farmers involved in irrigated maize farming is crucial for increasing agricultural productivity and enhancing food security in Zimbabwe. To achieve this, there is a need to provide appropriate training programmes that address the specific needs of smallholder farmers. Such training programmes should be designed to improve the cognitive, physical, and socio-emotional skills of smallholder farmers and should be accessible to all farmers, including women and older farmers.

Averbeke & Mohamed (2012) recommends that the South African government should consider an agricultural policy for the development of training and extension officers assigned to support the smallholder irrigation schemes (SIS) farmers. Furthermore, Mutambara *et al.* (2014) after a study in South Eastern Lowveld of Zimbabwe also recommended that farmers needed training in agronomic practices and marketing of agricultural produce. Nhundu & Mushunje (2010) indicated that these include training on proper agronomic practices, irrigation systems maintenance, record keeping and water scheduling among other factors. These services are vital for irrigation scheme sustainability to enhance the effective development and management of irrigation schemes for optimum production as farmers move from subsistence irrigation to irrigation as a business venture. Proper record keeping strategies then become vital for farmers to be viable.

Previously, agriculture in the Sub-Saharan and even West African countries used highly toxic pesticides on higher-value, frequently irrigated crops with low recognition of the negative impacts of such pesticides on the production, economy and health of communities and the environment. In Zimbabwe, as of 2018 some farmers resorted to using cotton pesticide as the pests had become resistant to the maize pesticides being applied. These chemicals are not meant to be used on harvest to be consumed by human beings as they are harmful. A better understanding of these and other elements in the production of irrigated maize can greatly improve farmers' decision making-skills and production in a more environmentally

friendly way (Settle, 2014). Maize farming is known to cause soil degradation (Brown, 2011), caused by the intensive application of inputs. Farmers need skills in soil fertility management aspects and knowledgeable in other methods of conserving the soil.

2.12.2 Irrigation water management skills

Worldwide, competition for water between people and animals is intense. Industrial development and urbanisation both have varied water needs. In most parts of the world, water scarcity hampers farming practices resulting in the shortage of food in homes.

Africa does not have enough water for intensive farming like double cropping resulting in effective water sharing and allocation arrangements being established by many governments (FAO, 2008; Muralikrishnan, 2021). Water stress, climate change induced droughts and withering droughts are affecting Africa's agricultural activities dating back to the 1970s. Climate change poses as a challenge to the already dire situation resulting in the reduction of water resources (UN, 2022).The only option to have meaningful yields in the drought prone areas is to supplement dry land farming with irrigation farming. The combination of the two agricultural methods will not only contribute to the securing of food within reasonable price range and foreign currency generation but also narrows the wealth gap within communities.

Best water management practices in irrigation schemes enhance water efficiency using irrigation technologies. Water retention could also be enhanced if watering is sanctioned during the night for evaporation reduction. Unlike surface water irrigation the use of centre pivots and sprinklers enables water conservation. It is on this argument that smallholder farmers need to know the actual water applications to plants to avoid unnecessary losses. From this assertion it is evident that securing water for agriculture is important to be able to satisfy the food demands in the ever-increasing population. Irrigation farming is a way of supplying water to plants at regulated intervals when and where there is less rainfall (Agrihome, 2018; FAO, 2010; 2015). The purpose of irrigation farming is to achieve high yields of agricultural production irrespective of rainfall availability. Irrigation was exercised in sub-Saharan Africa in the Niger River regions based on water harvesting and wet season flooding (Tandon, 2013).

The choice and knowledge of irrigation methods and technology determines the amounts of yields to be produced. Methods of applying water for irrigation include free flooding of entire

areas from canals and ditches, ridges or furrows. Other methods are the surface-pipe method, sprinklers, centre pivots and trickle systems. The main method that uses surface water is the floodwater system where water is directed to dry riverbeds through dams, gates and channels that would be spread over large areas.

2.12.3 Classification of Irrigation Technologies

Irrigation technologies have been identified as a potential solution to the challenges facing smallholder farmers in SSA (FAO, 2019). Several studies have shown that the use of irrigation technologies can significantly increase crop yields and improve the livelihoods of smallholder farmers (Gebregziabher *et al.,* 2018). However, Djurfeldt *et al.* (2017) argue that the uptake and active use of the irrigation technologies by smallholder farmers in SSA is still limited. The climatic variations worldwide, dwindling water supplies and the continual population growth have driven the need to look for other ways of conserving the precious liquid. Most countries have developed policies to do with water conservation to include irrigation technologies that are believed to achieve water savings in SSA (FAO, 2019).

There are various irrigation technologies or methods from the conventional to the modern ones that are being introduced to make full use of the little water available. The end users of these technologies need to be educated to make the most out of the irrigation systems. The domains of learning are vital as using these technologies depend on the mental capacity of the person involved. The irrigation method selected by farmers should be economically viable as some types have high operating costs and high installation capital although they may use less labour and uses water efficiently. Food and Agriculture Organisation (1999, 2015) reiterate that selection of irrigation method should be guided by the type of soil, topography and water supply. Tandon (2013) and FAO (2015) classify irrigation methods into pressurized and surface categories.

a) Pressurised irrigation methods

In the pressurised irrigation method, water is applied to the plants in a systematic way through pipes using the drip, sprinkler, rotary, centre pivot and drag horse irrigation. The pressurised irrigation method is more effective compared to surface irrigation. The methods include drip, sprinkler, centre pivot and drag hose irrigation systems (Webuadmin, 2015; Narayanamoorthy *et al.*, 2016).

b) Surface Irrigation Methods

The system applies and distributes water through simple gravity flow (Agrihome, 2018). Surface irrigation is considered as one of the commonest irrigation method throughout the world that uses the ditch, flooding and furrow technologies.

2.12.4 Irrigation technologies used in Chimhanda, Negomo and Eben Schemes

The three schemes that were studied make use of the pressurised method through the drag hose sprinkler irrigation. This pressurised method is an overhead method of irrigating crops suited for the schemes as they are located in low rainfall areas with less water. It is however, labour intensive as it involves moving equipment at intervals. Water used for irrigation is drawn from nearby dams. The choice of system used was the main technology that was introduced in pre-independence era, and it was considered that locals could not afford other technologies due to skills and costs. Another method used was the gravity method (flood) as it is cheaper and user friendly. Recently centre pivots were mounted at the three schemes.

Figure 2.3: Sprinkler Irrigation System (Source: Troy, 2017)

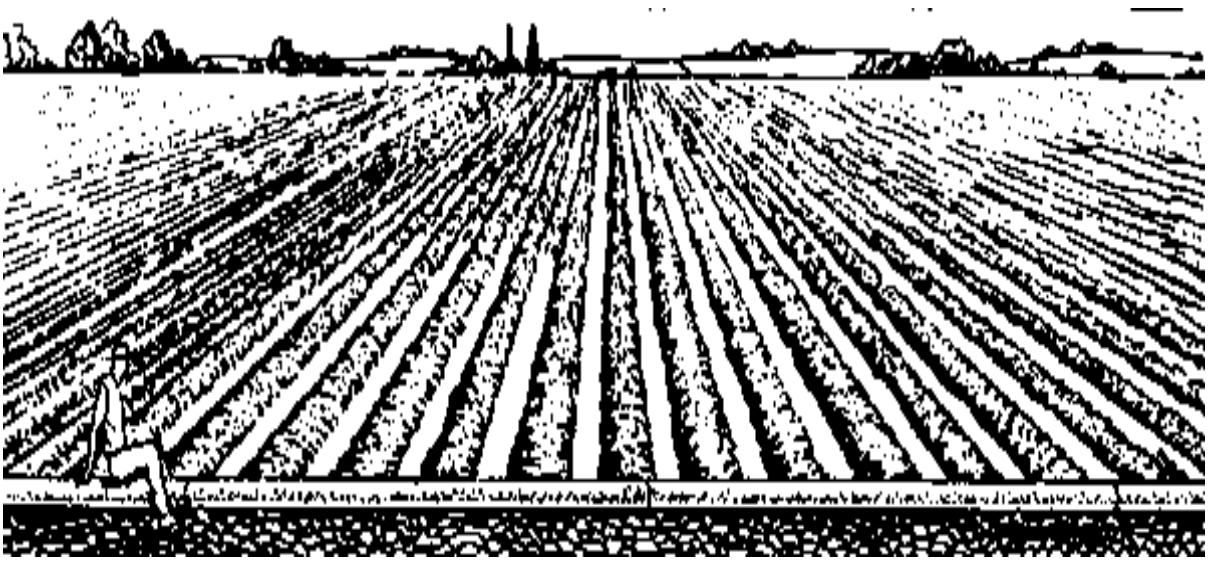


Figure 2.4: Furrow Irrigation (Source: FAO, 2017)

Training of farmers in issues such as water scheduling was recommended by Brown, (2011) and Settle,(2014). It was suggested that farmers should install regulation gates to stop uneven distribution of water. As spelt out in the Mhlanga *et al.* (2018), smallholder farmers in Zimbabwe lack the technical skills necessary for successful irrigation farming. This indicates that there is a need to enhance the skills of these farmers to improve their farming practices. This could be the development of skills to maintain canals so that weeds and vegetation do not grow (Bhalage *et al., 2*015). The issue of siltation and damages to canal linings should also be part of the skills that the irrigated maize farmer should possess for those using surface irrigation methods. This causes carriage of less or more water discharges.

Incorrect application of water might cause reduction on the farmer's production levels. This finding is also supported in a study by Mupangwa *et al.* (2012), which reported that smallholder farmers in Zimbabwe lack knowledge on efficient use of water resources, leading to inefficient irrigation practices. If innovative irrigation practices are introduced water efficiency is enhanced thereby gaining economic advantage as water is the backbone of irrigation farming (Levidow *et al.*, 2015).It is noted that 80 % of water resources available worldwide are used for irrigation purposes (Bhalage *et al.*, 2015).In Zimbabwe surface water was developed through building dams of which 80 % of the water is used for irrigation purposes (Chigumira & Mujere, 2009).

From the above review, it is evident that farmers have a variety of informational needs that include marketing, new hybrid seeds, planting, post-harvest methods, pest control and prevention of other plant diseases and (Bernard *et al.*, 2014) real weather conditions. Provision of relevant information enables farmers to make informed decisions. Reliance on knowledge passed on from parents, household members, neighbours and personal experience in agronomic practices is reduced. It is, therefore, necessary to put up agricultural information centres in all areas so that information is easily accessible. This always includes accessibility and availability of extension workers when the farmers face some challenges with regard to the ever-changing technologies (Bacchv, 2012).For this information to be useful, it must be timely, accurate, relevant, cost effective and usable considering age and level of education (Bernard *et al.*, 2014).These factors also influence the adoption of new agricultural innovations and technologies. For example, farmers at Negomo, Chimhanda and Eben Irrigation Schemes should have knowledge on the varieties suitable for their regions. In Table 2.1, it is indicated that all seed varieties are suitable for the two regions (II and IV) except for SC 637 selection that does not suit region IV even under irrigation because of its low tolerance

to drought and heat stress. SC303 is the earliest maturity that can be adopted for both dry land and irrigation purposes. SC437 is also an exception as it reveals that it can be adopted in all regions as it is tolerant to all traits. The annual rainfall for the two regions is 1000mm and 650mm respectively. Apart from knowing the output of the different maize varieties, farmers should be made aware of other benefits derived from adopting the new brand like the SC 643. As noted, this is a high-quality protein maize that helps in producing stock feed for livestock such as pigs. This aids in the dietary improvement and diversity in households.

2.12.5 Attributes of Agricultural Extension Officers

Agricultural extension workers have the mandate of disseminating useful information to the people they work with, encouraging them to adopt the new ideas. The success of an extension worker is determined by the effectiveness and efficiency of communicating the required information at the right time to the right people in the right manner that is understandable (Chauha, 2007).In extension education, communication means the transferring of skills, attitude and an idea from one person to another accurately and satisfactorily. Mutambara *et al.* (2014) argues that some Extension officers lacked the requisite qualifications and experience commensurate with production levels in the schemes as some of them did not go under intensive training. These agricultural extension workers lack the basic communication skills to effectively render the necessary support to the farmers. Often institutions ignore human capital development that deals with personal knowledge, attitudes and behaviour favouring the improvement of institutions and infrastructure.

Other attributes of the officers include honesty, trustworthiness, interest and willingness to work with the farming communities. It has been noted that (Sani *et al.,* 2015) the success of any extension work is dependent on the power of motivation as stated and being capable to organise people such as when conducting demonstrations or field days and being able to control and manage the activities of the extension office. Above all the EO should have the knowledge of social, values and norms of the area operated on. It is of paramount importance to respect people's anthropological and sociological structures to gain respect from the community.

Table 2.1: Maize seed varieties suitable for agro-ecological regions I and IV irrigation

Seed variety	Description
SC 727	1. Considered the highest yielding hybrid in Africa. Farmers getting yields up to 21 t/ha in some irrigated areas. 2. It is a late maturity white maize hybrid with a period of (155-160) days to reach maturity level. 3. It is heat and drought tolerant. It is also tolerant to common maize diseases. It is suitable for both dry land and irrigated farming, which is recommended for regions, 1, 2 and 3 in Zimbabwe.
SC719	1. This variety is considered as the farmers' first choice in irrigated maize production. It yields up to 21 t/ha when managed well. 2. It has late maturity. Takes (148-155) days to reach maturity. 3. The variety has been globally accepted as a top performer across all environments and seasons. 4. High tolerance to maize diseases in Zimbabwe
SC649	1. Medium maturity white maize which takes (135-145) days to mature. 2. It has the highest yield in Zimbabwe with up to 16 t/ha. 3. It has an excellent disease tolerance, heat and drought stress adaptation.
SC 637	1. Medium maturity white maize taking (135-148) day to reach maturity. 2. Highly regarded by irrigators for high yield potential of up to 16 t/ha. 3. Mild tolerance to heat and drought stress tolerance. 4. Good tolerance to common maize diseases in Zimbabwe.
SC 627	1. Medium maturity maize taking (135-144) days to reach maturity. 2. Yields of above 10 t/ha and widely adapted across different environments. 3. Excellent tolerance to major maize diseases in Zimbabwe. 4. Variety recommended for the regions, I, II, III and IV.
SC 643	1. This variety is a Quality Protein Maize with high levels of amino acids needed for animal feed like pigs. 2. Medium maturity hybrid (135-141) days to mature. 3. Excellent drought and heat stress tolerance. 4. Variety recommended for regions II, III and IV irrigation. 5. Yields of up to 12 t/ha.
SC303	1. Ultra-early maturity maize variety taking 100 days. 2. Currently high yielding hybrid in sub-Saharan Africa. Yields up to 10 t/ha 3. Excellent heat and drought stress tolerance 4. Resistant to crop diseases. 5. Ideal for regions IV and V both dryland and irrigation 6. Suitable for multiple planting with irrigation
SC437	1. This variety matures in 112-119 days depending on altitude. 2. Yield up to 12.5 t/ha 3. Good heat and drought tolerance 4. Ideal for wheat and maize rotation. 5. Suitable for region IV and V.
SC547	1 Reaches maturity in 121 – 128 days. 2. Yield up to 12t/ha 3. Widely adapted variety

Source: SEEDCO (2018)

2.12.6 Required skills and roles of agricultural extension workers

Agricultural extension workers or officers are regarded as teachers, philosophers, leaders and guides in the community that they serve. Introduction of new ideas and the endeavour to bring about change in the farmers is the work of the extension worker. For training methods to add value and be effective, extension officers need sound knowledge of the subject-matter to be delivered, practical agricultural experience and expertise. This is the best ingredient to impress people and win their hearts to facilitate change of attitude (Sani *et al.*, 2015). The knowledge acquisition through research is a major challenge in developing countries with Zimbabwe included. Extension Officers lack the necessary equipment like computers to use in their work. The printers, if there are any, are centralised and monitored by the supervisors who check on what is being printed. Depending on the personality of the supervisor access may be denied using the computer.

One of the challenges faced by extension agents is that most of them are based full-time in rural areas where there is no internet making it even more difficult to get extra information. To get connected they would need to use their mobile phones and meagre resources for them to get that extra information and impart it to farmers through the group platforms formed on the mobile phones. It also works to the disadvantage of farmers as not all participants have mobile phones to get the send messages. However, despite some of the challenges listed, the EO is expected to provide prompt and relevant solutions to the presented problems. The officer should be readily available and accessible when clients need services (Lukuyu *et al.*, 2012). In addition, the personality of the EW should be attracting people meaning the person should be easily approached and that people are not hesitant to consult. Tolerance of all situations should be developed by the extension officers as opposition from the communities is inevitable and unavoidable.

To work with smallholder farmers in irrigation schemes, extension workers need to have both agricultural and extension skills. Some of the skills include understanding why crop improvement should be implemented by being able to interpret the prevailing agricultural environment whether in drought or flooding times and the crop management under these various climatic conditions. The EO should be a `hands on' person with technical skills that are relevant to maize production. Government legislation and other policies should be familiarised with developmental programmes that affect the areas under consideration. Adult education six core principles should guide the extension worker in the day-to-day activities to

develop farmer participation in agricultural extension projects. These principles are: adults are self-directed, they know what they want, they have prior experience that had been accumulated over the years hence they are goal oriented when they come to learning situations (Bush, 2018). Public speaking skills and confidence are necessary in agricultural extension (Lukuyu *et al.,* 2012). This skill must be developed for effective communication during community gatherings such as field days or on demonstration plots (Sani *et al.*, 2015). It gives the audience a positive attitude towards the work of the extension officer.

Extension officers are committed people who normally work under difficult conditions with little support especially in the developing world and high farmer-officer ratio. However, the work demands that the extension officer be dedicated, humane and a hard worker who should be prepared before embarking on extension services to gain farmer confidence and acceptance.

2.13 Conclusion

Smallholder farmers in Zimbabwe resorted to irrigation as a way of mitigating the effects of climatic variations and increase crop productivity. Irrigation technologies can help smallholder farmers to improve crop yields, stabilize production, and reduce vulnerability to climate shocks. The adoption and effective use of irrigation technologies by smallholder farmers in Zimbabwe is affected by factors that include limited access to credit and technical assistance, poor water management practices, and insufficient knowledge of irrigation system maintenance and repair.

Innovative approaches to training and extension services provide a solution to some of the challenges faced by smallholder farmers, particularly in knowledge and skills transfer. In this context, a learning domain-based training approach provide an effective means of supporting smallholder farmers in Mashonaland Central Province to improve their maize farming practices and increase their productivity. Needs assessment help in proper programme planning and implementation. Resources are not wasted by duplication of projects or introducing activities which are shunned leading to their failure. The cognitive level of participants should be assessed for the programmes to achieve intended results. Several agricultural approaches introduced earlier concentrated on transfer of technology to the farmers without considering the mental capacity of participants. The top-down approach led to failure of these approaches.

The perceived effectiveness of current training approaches on irrigated maize performance depends on various factors, such as the content of the training, the delivery methods, and the context of the farming communities. As such, there is a need to explore alternative training approaches that are tailored to the specific needs and circumstances of smallholder farmers involved in irrigated maize farming. Training interventions that focus on improving farmers' knowledge and skills in soil fertility management, pest and disease control, and marketing have to be considered as they lead to improved yields and increased income among smallholder farmers.

No one approach can be said to suit all farming situations. There are advantages and disadvantages associated with every method as a single entity. A learning domain-based approach is one potential solution that was proposed to address the challenge of low productivity in Mashonaland Central Province. An improved learning domain-based framework for training farmers in irrigated maize farming could be developed through collaboration with farmers and other stakeholders. This framework would be designed to address the specific needs and challenges of smallholder farmers in Zimbabwe and would be tailored to their individual learning needs. The framework would be based on the principles of adult learning and would include a range of activities such as group discussions, field demonstrations, and practical exercises.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

In this chapter, the research methodology used in the current study is presented. The study site, research design, population and sampling procedures, data collection tools, data analysis methods and ethical considerations are described and justified. Ethical measures considered in this research are explained.

Knowledge that has been acquired by farmers in the study areas cannot be measured without a thorough examination of the farmers' understanding of all aspects involved in the irrigation systems for better production. Hence, the level of competence of any human being at work or in the performance of any task is assessed through considering his or her level of development through training. The learning domain theory provides a theoretical framework that can inform the development of effective programmes for smallholder farmers (Van Eerder *et al.,* 2013). As argued by theory, learning occurs within a specific domain which is characterised by a set of interconnected concepts, procedures and principles. The learning domain-based training approach focuses on providing training that is relevant and meaningful to learners by aligning the content with their specific domain of knowledge and experience.

The three basic domains of human learning (Randall, 2011) include the *Cognitive* (theoretical or intellectual). Knowledge, comprehension, application, analysis, synthesis and evaluation of learning collectively define the cognitive domain that is centred on using mental skills (Clark, 2015). All activities start from the mind that is the knowledge base of information. In the *Affective* (humanistic) domain, as argued by Phillips (2009) and Anderson & Krathwohl (2010), participants in any learning situation are expected to change attitudes, values and appreciation. Active participation by learners indicates that new experiences have been opened. *Psychomotor* (manipulative or skill development), domain encompasses manipulative performance or actions. Through practice, skills are developed with accuracy, procedures or techniques in the execution of the task being measures of improvement (Anderson & Krathwohl, 2010; Randall, 2011; Ndlovu, 2013). This is the best approach to adult education as it caters for all categories of people using hands, legs and eyes. Cognitive and psychomotor domains are combined for better articulation of the problem at hand. Knowledge, Attitude and Skills (KAS) are taxonomies of learning behaviours that form the basis of achieving the goals of the training process. The three domains of learning explained above

anchored this study that was designed to examine how smallholder farmers involved in irrigated maize farming exercise the domains for improved production.

3.2 Description of the Study Area

Zimbabwe is a landlocked country in Africa. It shares borders with Mozambique, South Africa, Zambia and Botswana (Figure 3.1). The country lies on longitude of 33.050 and latitude of 15.610. Its total coverage is 390757 km^2. Of the total area, 386847 km^2 is land and water cover 3,910 square metres (ZimAtlas, 2016). Zimbabwe is the 61st largest nation in the world. Vincent and Thomas (1959) divided the country into five agro-ecological regions (NR) based on the amount of rainfall received and other climatic variables.

Farmers suffer from a crisis of unsustainable agricultural production, malnutrition and persistent rural poverty caused mainly by weak knowledge bases, poor production and market linkages that causes the production to remain low (FAO, 2015). Storage facilities of the grain after harvest posed as a challenge that required training (Matondi *et al.,* 2017). These challenges are particularly acute in Mashonaland Central Province where smallholder farmers face high levels of poverty and food insecurity (Nelson *et al.,* 2020).

Mashonaland Central Province, where the current study was undertaken is home to 1 152 520 people. Approximately, 51 % of these are females (ZIMSTATS, 2014). Out of those who are employed, the highest proportion (69 percent) is engaged in agriculture related occupations. This justifies why the province is one of the best areas in terms of agricultural production and is considered the breadbasket of the country. The province's intensity in farming activity compelled the researcher to select it as her study area. The province falls under Natural Regions (NR) II, III and IV. Natural region II receives 700-1050 mm rainfall per year in summer (FAO, 2000) (Figure 3.1). Flue-cured tobacco, maize, cotton, sugar beans and coffee are the major crops grown in NR II. Small grains and various horticultural crops are also grown. Smallholder farmers occupy only 21 % of the area in this productive region. On the other hand, NR III is a semi-intensive farming area with rainfall ranging from 650-800 mm.

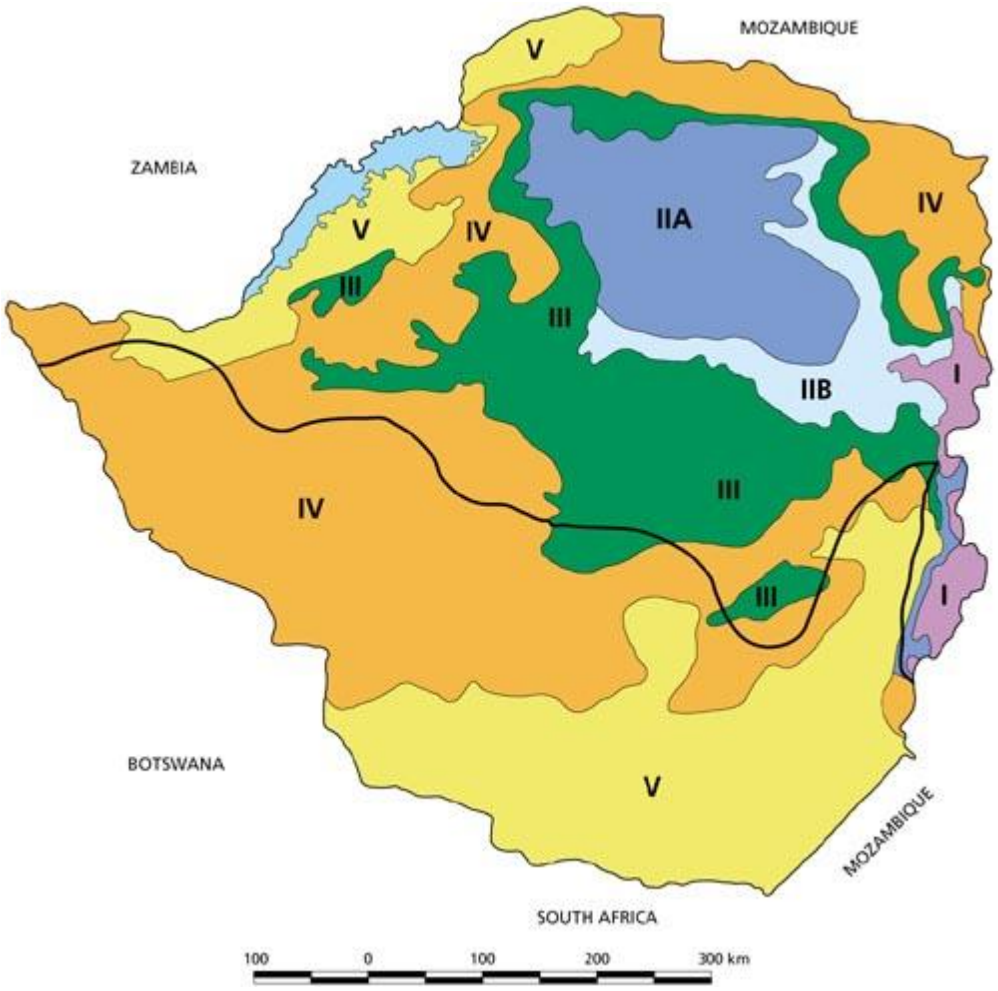


Figure 3.1: Zimbabwe Ecological Zones (Source: Google maps May, 2015)

Key: Natural Regions

I	Specialised and diversified farming region
IIA	Intensive farming region
IIB	Intensive farming region
III	Semi-Intensive farming region
IV	Semi-Extensive farming region
V	Extensive farming region

Prolonged seasonal droughts and unreliable start of the rainy season are common hence the need for supplementary irrigation for crop production sustenance. Smallholder farmers occupy 395 % of the area with 15 % dedicated to crop production with maize being the main crop. Natural region IV is a semi-extensive farming region. On average the region receives between 450-650 mm of rainfall per annum that is not sufficient for dry land farming without supplementary irrigation (Vincent & Thomas, 1961; Rukuni & Eicher, 1994). Smallholder farmers occupy 50 % of the area. The importance of irrigation to sustainable agricultural production, food security and employment creation is highlighted by the GoZ (2012). In view of this, rehabilitation and modernization of irrigation schemes to increase the area under irrigation is a key objective of GoZ. Evidently, the unreliability of rainfall in Mashonaland Central Province and the emerging negative impacts of climate change calls for the intensification of irrigation-based strategies for sustainable agriculture development. Such a situation also provides a case for undertaking the current study that is meant to contribute to improved productivity of irrigation schemes in the province.

The province has 16 small-scale irrigation schemes (SIS). The irrigation schemes under study are communal irrigation schemes located in Mashonaland Central Province that produce maize. The 16 SIS were clustered as spelt out in the distance from the major market that is Mbare Musika in Harare. Another aspect considered was the distance of the schemes from the city centre and the remoteness of the scheme. Another criterion used was the establishment period of the irrigation scheme. This was whether it was established before the Fast Track Land Reform (FTLR) of 2000 or after the FTLR. The district study areas chosen were Shamva (Eben), Mazowe (Negomo) and Rushinga (Chimhanda). The three community-owned SIS were purposively selected for the study. Eben and Negomo fall under NR II, an intensive farming area that receives a higher amount of rainfall than Chimhanda that is in NR IV. Two schemes, Negomo and Chimhanda were purposively selected after considering the sizes of the schemes and the fact that they were established in the pre-land reform programme that is before 2000.

Distance from urban settings was also considered in the selection of Chimhanda Irrigation Scheme having the furthest distance of 225 km from Harare the capital city of Zimbabwe and being more remote. Eben was chosen based on its proximity to Harare being the mid-point of the other two irrigation schemes with 118 km from the city centre. Another criterion for choosing Eben was that it was established in the post land reform programme period. The age of the scheme was also a factor in examining the low productivity in these schemes. The

distances of the irrigation schemes range from 90 km from Harare the largest city to 250 km from the city centre (MoAMID, 2014). Feasibility for research influenced the selection of these three sites for research. Data were freely available from the provincial officers and local extension officers. The choice was also based on no risk related between researcher-farmer conflicts. The regions have red and sandy soils but generally there is degradation from fairly rich to poor soils as we go further from the city.

As is the case with other parts of Zimbabwe, the households in Mashonaland Central Province rely on agriculture as the country is agro-based (ZimVAC, 2017). Literature reveals that plot holders who work on the schemes are both full-time and part-time. Some farmers have other pieces of land outside the irrigation schemes where they do dry land farming in summer to boost household economy. However, the communities still rely on traditional techniques of farming as evidenced by the low productivity in the irrigation schemes. This has caused the province to experience localised food shortages.

3.2.1 Attributes of the irrigation schemes

The irrigation schemes that were studied were found in Shamva, Rushinga and Mazowe Districts. The schemes studied differed in size and the irrigation schemes made use of sprinkler type of irrigation (Figures2.3 and 2.4).

a) Negomo smallholder irrigation scheme

Negomo small-scale irrigation scheme that is in the Mazowe District of Mashonaland Central was established in 1996 (Figure 3.4). The scheme lies in region II where there is enough rainfall thereby making it possible even for dry land farming (AGRITEX, 2010). It is on 394 ha of irrigable land. It is the largest scheme among the three studied and the nearest to Harare with a distance of 90 km. Its proximity to the city has led to many agricultural stakeholders to favour this place. The scheme houses 296 beneficiaries comprising 80 % males and 20 % females. It is divided into three blocks (A, B, C) and manned by three extension officers. The original settlers in the scheme were people who were displaced during the development of the scheme, and they were the first to be offered plots as compensation. A few additional members were then selected by the Irrigation Management Committee (IMC). Plot holders were allocated an average of 0.5 ha to 1 ha of land depending on whether one is an original villager who was displaced or those who were allocated based on other factors. These members were trained in Operation and Maintenance at the inception of the project.

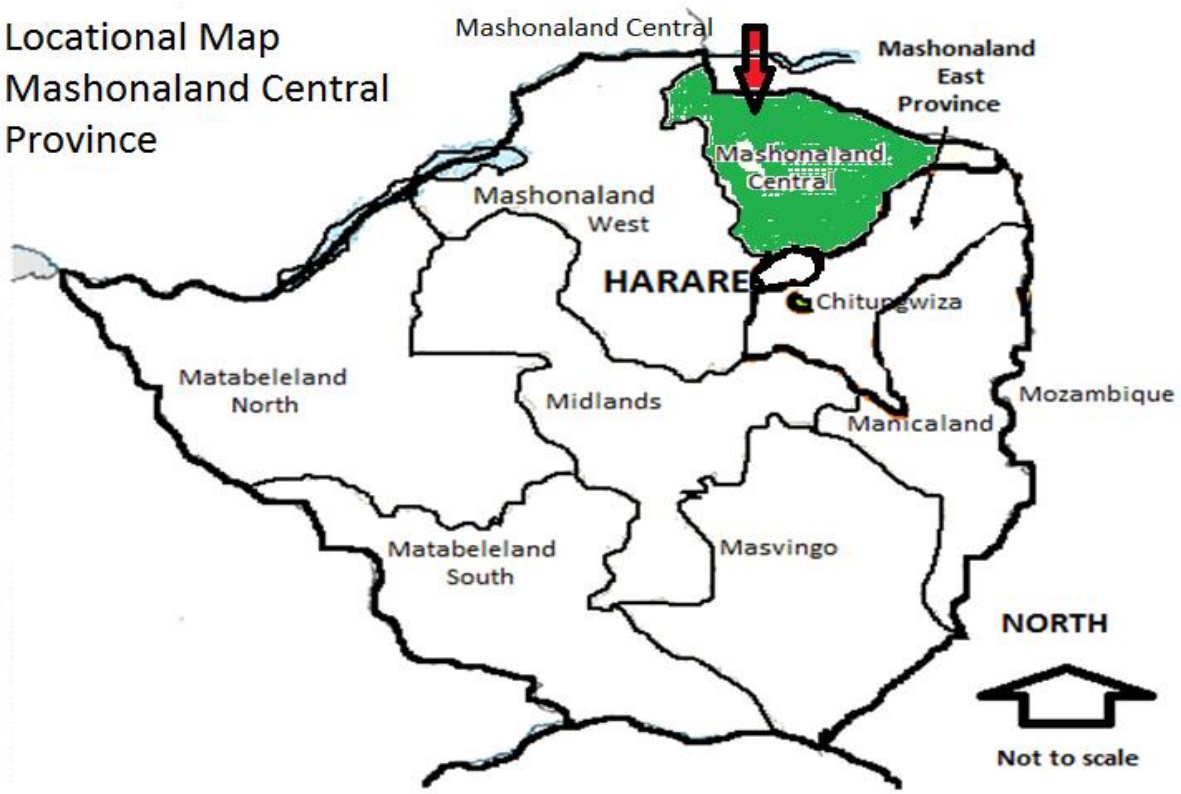


Figure 3.2: Locational Map of Mashonaland Central**: Source: Author (May, 2015)**

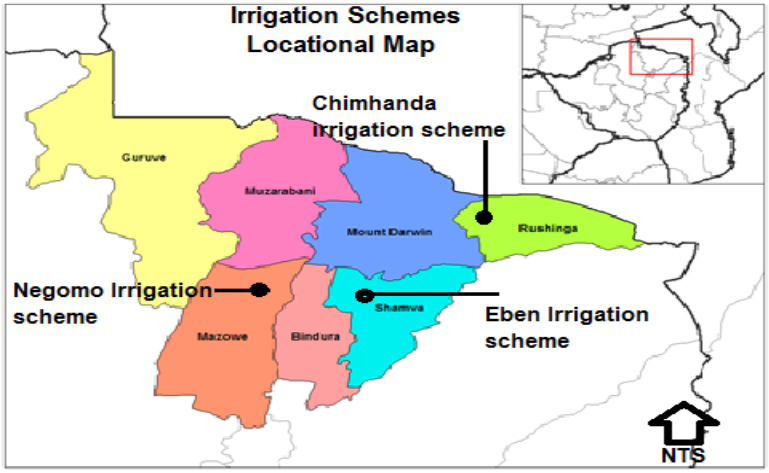


Figure 3.3: Mashonaland Central District Map Showing Study Areas (Google maps: May, 2018)

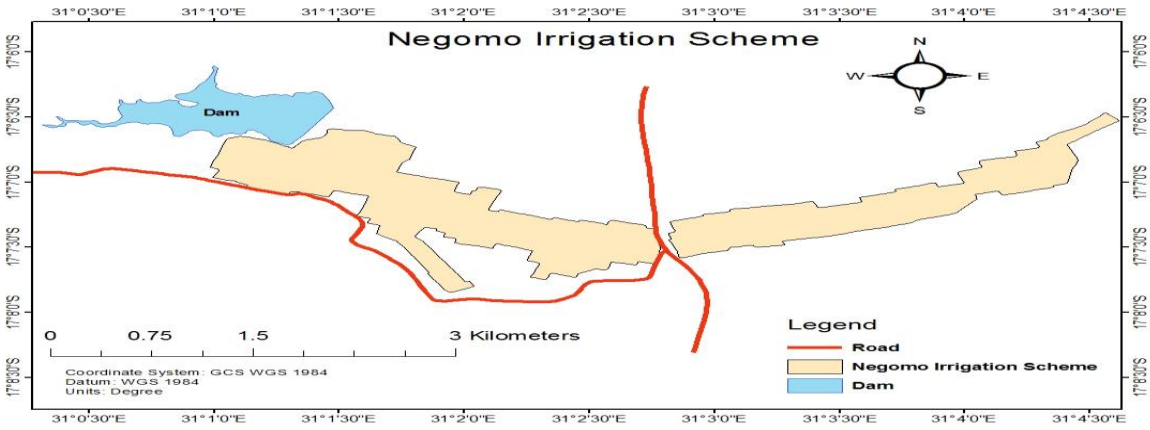


Figure 3.4: Negomo Irrigation Scheme **Layout: Google Earth February 2017**

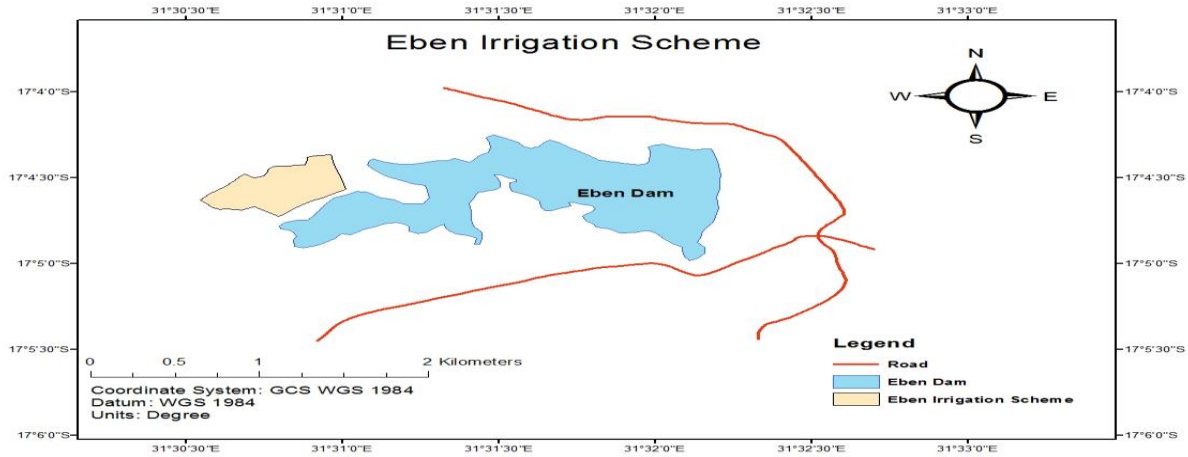


Figure 3.5: Eben Irrigation Scheme **Layout: Google Earth February 2017**

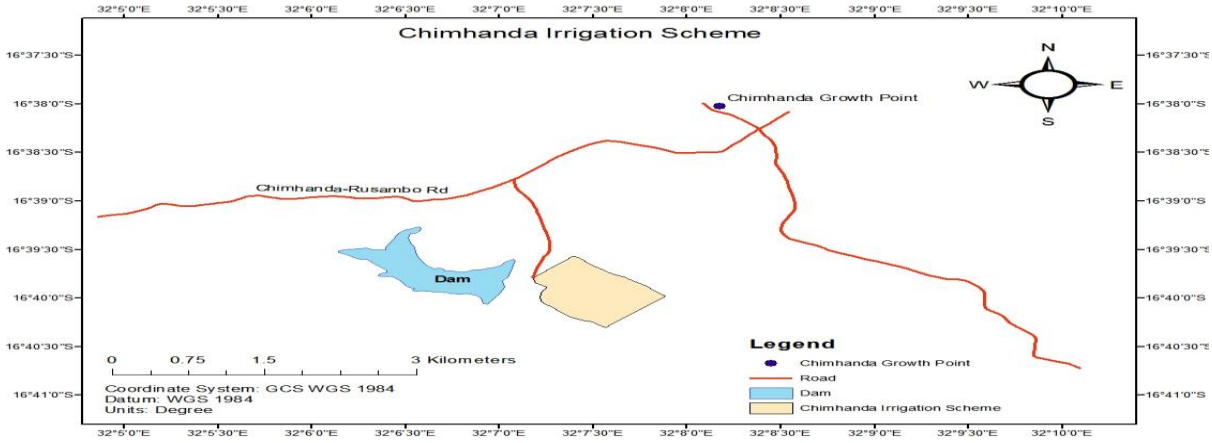


Figure 3.6: Chimhanda Irrigation Scheme **Layout: Google Earth February 2017**

b) Eben smallholder irrigation scheme

Eben Irrigation Scheme (Figure 3.5) in Shamva District of Mashonaland Province was established in 2011. It occupies 20 ha of land and has a membership of 42 farmers comprising 75 % males and 25 % females (AGRITEX, 2010). The land is divided into two blocks to facilitate watering of crops. The scheme is 125 km from Harare, and it is the midpoint of the selected three provincial irrigation schemes. Eben Irrigation Scheme membership was derived from villagers who had Master Farmer Certificates and those who had relatively good yields every year. There were also villagers who were displaced by the expansion of settlements such as growth points, roads and other developments who were also considered for land allocation. Rural District Council had a waiting list that was generated hence other members were selected from the list. Allocations of 0.5 to 1 ha were done depending on the status of the farmer (AGRITEX, 2010).

c) Chimhanda smallholder irrigation scheme

Chimhanda smallholder irrigation scheme (Figure 3.6) that lies in Rushinga District was established in 1992 (AGRITEX, 2010). It occupies 67 ha of irrigable land and is divided into three blocks to allow water management during irrigation. The scheme has 134 beneficiaries and is at 250 km from Harare. This scheme is the furthest away from town. The percentage ratio of farmers is 75 % males and 25 % females. The call was extended to the community to join the scheme. Those who volunteered dug trenches and were allocated 0.5 ha plot sizes. Those whose homesteads were disturbed were given double share of 1 ha as they did not have any other land left to cultivate.

3.3 Research Design

Both quantitative and qualitative designs were adopted. The research was mostly descriptive in nature. Participants' behaviour was observed and described at their natural settings. A KAP survey research design was used. A sample survey was useful for development and planning purposes. This justifies the choice of the research design for this study. It entailed gathering raw information from a representative sample of respondents drawn from farmers at each scheme without affecting their normal behaviour or day-to-day activities. To get insights on the welfare of the participants, nominal group discussions and key informant interviews were held thereby collecting qualitative data.

After analysis of the qualitative data, a comprehensive questionnaire was crafted to include food consumption patterns data. Household interviews where the type of accommodation and acquisition of domestic and productive assets were recorded were carried out. Thus, the research design in its final phase linked the data from the two approaches in this research coming up with an improved training framework to be used in the smallholder irrigation scheme (Berman, 2017). Furthermore, the training of farmers in irrigation schemes under study could not be explained using one method to unravel the causes of failure to produce sustainably. Mixed method research design was therefore implemented for this cause. Also, Hanson *et al.* (2005) suggested that the design is ideal when all the variables are not known and where explanation of findings is required. Using mixed design added rigor, breadth, complexity, richness and depth to the inquiry. By triangulating more value is added to the research findings as bias is eliminated (Creswell, 2012). The research design helped in establishing the relationship between knowledge, attitude and practices of a community of a particular intervention. Hence the application of Knowledge, Attitude and Practice (KAP) survey is to assess what people know and what they should know thereby filling the existing gap.

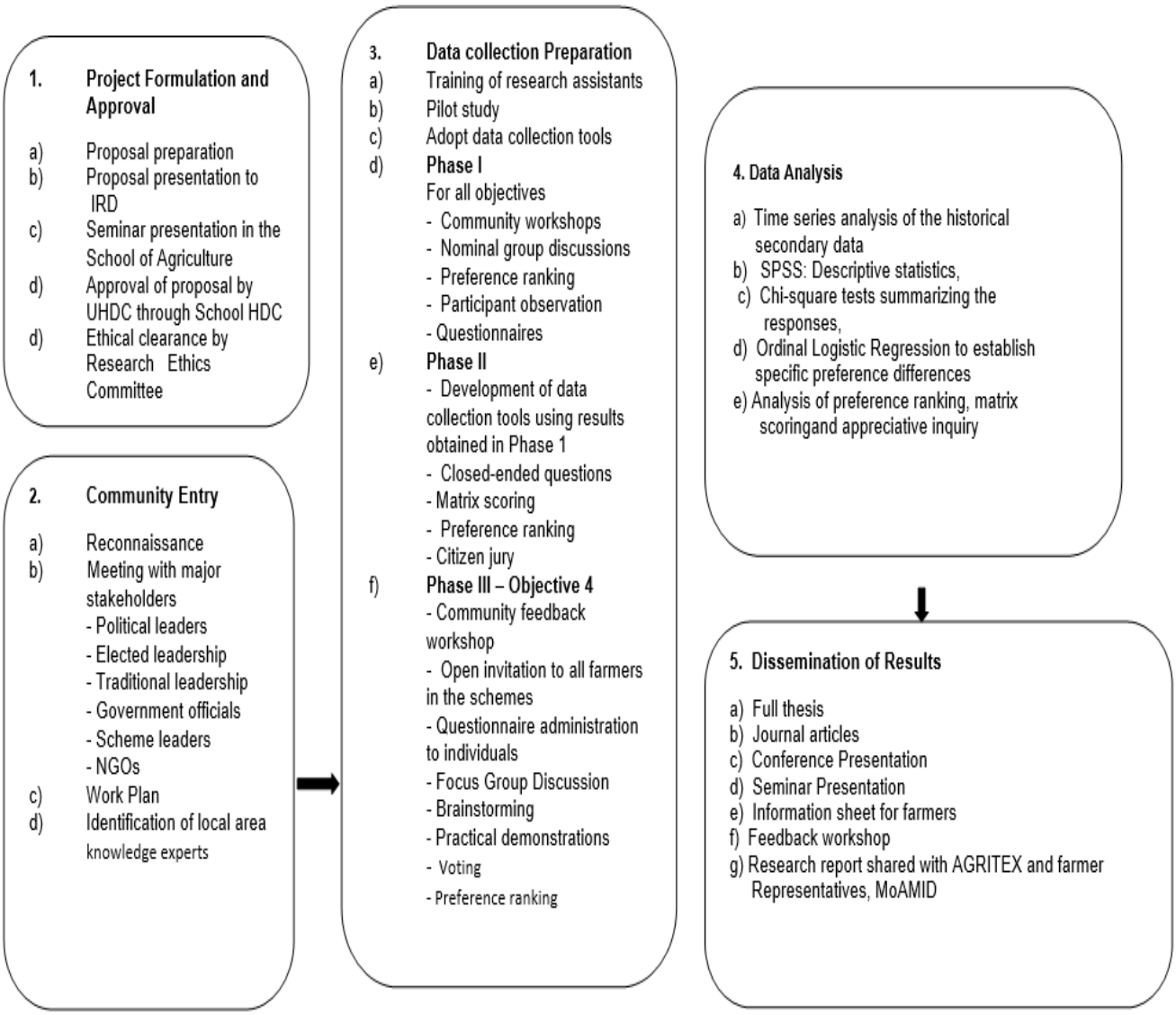


Figure 3.7Summary of research approach used to determine how the domains of learning can be applied in the training of irrigated maize smallholder farmers

3.3.1 Community entry

A reconnaissance trip was undertaken to gain admission and authorization as preliminary phases before rolling out the research in the community. Community entry for the study was done in April 2018 after being cleared by the Ministry of Lands Agriculture Fisheries Water and Rural Development. Contact details for all extension officers from Province, District and scheme level were acquired through the Director of Agricultural Rural Development Advisory Services (ARDAS). This process fulfils the Ardichvili *et al.*(2013) suggestion that community entry activities are critical for the active involvement of participants through creating cordial working relationships and trust. Telephonic conversations were undertaken with the Provincial ARDAS official. The researcher was authorized to contact the District Extension Officers (DEO) who then facilitated links to the scheme officers. Agricultural extension officers manning the relevant schemes contacted the IMC leadership informing them of the intended research. This formed the initial interaction point with the community in Negomo, Eben and Chimhanda Irrigation Schemes.

Traditional leaders were consulted as a formality per district. In Rushinga transport was availed for use during the research period to get to the scheme as it was 15 km away from where the researcher was staying. At Eben the IMC chairperson, offered his home as there was no accommodation nearby. A work plan for conducting data collection was agreed on. After this reconnaissance visit, the research emphasis was redefined to incorporate some of the perceptions that had been left out. A meeting was held with IMC leadership on the next community visit that was conducted after refining the research focus. This occasion was used to request for consent to conduct the research and clarification of ethical concerns.

Research assistants were trained on how to gather qualitative and quantitative data whilst observing research ethics that governs research work. The assistants included youths from the irrigation schemes and one PhD student from the University of Venda. These assistants were better placed because they had experience in data collection as many researchers had visited the schemes and the PhD student had done many researches.

Qualitative stage involved key informant interviews, focus group discussions and observation and participatory rural appraisal methodologies. Participatory Rural Appraisal describes several approaches and procedures that allow residents to share and examine their

understanding of conditions and life. The PRA techniques assisted the researcher to gather data in a reasonably short period considering three schemes were involved in this study.

3.4 Target Population and Sampling Procedures

Irrigation schemes that focus on maize production in two natural regions, that is, NR II and IV of Mashonaland Central were investigated. The study of these schemes allowed the actual testing of the extent to which the schemes vary in key variables (trained/untrained). The lists of all farmers were obtained from MLAFWRD offices in Mashonaland Central through District Administrator and later verified by the irrigation scheme extension officers. These lists formed the sampling frames for the household sample survey. Stratified sampling procedure was employed to select a study sample for the irrigated maize farmers.

Targeted households considered in the sample were 472 of registered farmers in all the three schemes. Each irrigation scheme was regarded as a stratum. The total population for household surveys was used. Census method was adopted to allow for non-participation and returns during data collection. This sampling method is known for its reliability in results obtained. Ten (10) key informants in the irrigation schemes were interviewed. Six FGD were held with 2 groups per scheme as spelt out in the farmer listing. The methods were applicable to all the objectives of the study. Further, convenient sampling was employed as participants were easily accessible and available to the researcher.

Farmers were attending the Presidential input loan scheme meeting. This necessitated the adoption of a convenient sample for data collection especially at Chimhanda. Some of the farmers identified were readily available at their irrigation plots at the time of collecting data. The proximity of the irrigation scheme compared to farmers' households in Negomo prompted the use of convenient sampling again. It was highly likely that participants would be found working in their plots than finding them at their homesteads. Finding participants at one place and at irrigation sites became time and cost saving than to conduct research at the farmers' respective households. Therefore, convenient sampling enabled the researcher to gather rich in-depth data and first-hand information through direct observation as participants were carrying out their daily activities. This satisfies KAP model as real data was collected without disturbing the everyday life of participants. Those farmers who participated in the study voluntarily were requested to sign the informed consent forms.

3.5 Data Collection

Maize farmers, specifically the heads of households, were the units of analysis. Participants were visited at their plots for discussion meetings that were done using interview schedules. The interview answers were recorded on the interview schedule. Data on observed objects were recorded by the researcher in a notebook. Features observed comprised the sizes of the farming land, family productive and household assets, type of dwellings in the homestead for those that were in the scheme's vicinity, and the water sources.

Both secondary and primary data were collected. Use of internet was instituted as desk research for secondary data. Library facilities to get Agricultural reports and Educational Institutions like Kushinga Phikelela Agricultural College were visited. Newspapers, magazines, radio and television were part of secondary data collection methods. Secondary sources included the Zimbabwe National Statistical Agency (ZIMSTATS), Ministry of Lands Agriculture Fisheries Water and Rural Development (ARDAS) division and NGOs that had been sponsoring the construction of irrigation schemes in Mashonaland Central and those that had helped in the community. A formal structured household questionnaire was used for data collection. Interview guides were also administered for all objectives with farmers and extension officers in the districts as key informants. The primary data collection was done in three phases.

Phase 1 was community entry for action plan. Community workshops were meant to be organised and these were to comprise four groups in each scheme with 6–32 members per group. The workshops were not held because of lack of resources. The researcher resorted to mobilising the farmers that were conveniently situated. Nominal group discussion approach was used for all objectives. Complementary field research methods included questionnaire surveys, formal and informal discussions and participant observation. To institute citizen jury process, a representative sample of randomly selected members of the community was briefed to deliberate and make recommendations on the preferred training approach (section 3.4.5).In this case farmers made a recommendation on the appropriate or preferred training approach that was seen to be the best. The advantage was that other members gained confidence in the decision as they were made by fellow farmers, thus, promoting ownership of agreed actions. Preference ranking another participatory technique was used to identify problems or preferences in the hope of providing solutions to the problems faced by the community. This triangulation of different research methods allowed incorporation of farmers' agricultural knowledge for better agronomic practices.

In phase 2, the same template used for Objective 1 was applied to deepen and understand issues underlying all objectives. A closed-ended questionnaire, preference ranking, 7-day meal recall process, self-assessment and citizen jury were employed to gather more data pertaining to agricultural training received to date, their impact and the methods of instruction employed. The phase was meant to assess the incorporation of the cognitive, affective and psychomotor domains in the training of participants.

Phase 3 was for community feedback workshop that focused on the agricultural framework. Questionnaires were administered to individuals in the workshops and then breakaway groups formed. This method allowed for soliciting of views from the farmers as they shared experiences and knowledge. It was an open invitation to every farmer involved in the schemes. The community endorsed results for adoption of the current or propose a new framework that would enhance maize production in the schemes.

3.5.1 Key informant interviews

Key informant interviews (KII) were held with 10 people. These were 1 Director from the Ministry of Agriculture, 1 Director of COMMUTECH,1 Director from Ruzivo Trust, 1 Director from Lead Farmer Trust, 3 District Extension Officers, 3 Agricultural Extension Officers. Key informant interviews provided answers to the not so obvious questions that related to the trainings undertaken. The perception by farmers as to the enrichment of those training approaches applied were also initiated (Appendix 8). Key informant interviews did not only help understand the extent of the application of learning domains in the training of farmers but to explain the how, why and when part of the training component. Key informant interviews provided rich in-depth information that would not have been said during group meetings.

3.5.2 Focus group discussions

Focus group discussions facilitated the collection of data using the structured guide for discussions (Appendix 7). The interactions enabled participants to react to responses from other group members. However, the mixing of participants contradicts what feminists advocate for. Harding (2004) argues that men and women are totally different from each other and therefore, must be studied separately in their own right. This entails grouping men and women separately for trainings even during such discussions so that participants can air their individual views freely. In this study no variables were taken into consideration in the arrangement of participants for focus group discussions as it was the same method used

during training sessions. By using the same method, it was a way of observing how participants behave or respond when mixed as such. Ethical considerations were also clarified during the gathering. The respondents were informed about consent. Permission to voice record and take pictures was also sought.

The advantage of using the FGD method for data collection was its ability to collect large amount of data from a relatively large number of participants at the same time. However, the non-categorizations of participants acted as a barrier for women participants to express themselves freely because of cultural norms. Rapport was established between researcher and participants as the group methods enable those participants with no experience in public speaking get the opportunity to speak out. In the set up only IMC women members were very confident and free to express themselves. Transcription of answers from the group was recorded by the research assistants.

3.5.3 Citizen jury

Citizen jury is a gathering of community members who listen to realities and evidence of a case to make informed choices (Kothari & Garg, 2014). This process was used to propose an alternative framework or to improve the current training framework in the irrigation schemes for better outputs. Members were requested to indicate their choices on the guide that was provided as a way of extracting information from the participants. Citizen jury is premised on the understanding that communities can solve own problems affecting their welfare. This way the formal top-down method of problem solving is avoided. The group discussions allowed jury members to propose suggestions and recommendations for further implementation.

The jury was coordinated by the researcher as it requires good negotiation and facilitation skills as noted by Blanche *et al.* (2012). The citizen jurors were pre-determined to ensure that groups contained jurors of both socio-economic status and gender. Group leaders made sure that each jury member had a chance of contributing during the proceedings. The format of the discussions and group norms were relayed to members. Jurors had the role to select responses that best suited their opinions. Questions related to the effectiveness of the current approach and whether it should be replaced or strengthened were asked. Participants were allocated 10 minutes to provide their answers. The approach encouraged citizen participation as is the emphasis of the Bloom's taxonomies of learning domains. Its aim is to develop an individual who can solve own problems by active participation rather than to be a receiver of

already made decisions. The citizen jury assisted in evaluating the current training approach and conclusion of the discussions was made.

3.5.4 Knowledge Attitude and Practices (KAP) survey model

The purpose of conducting a KAP survey was for the collection of quantitative data of a phenomenon through questionnaires and statistically analysing the data collected. A total of 208 members participated in the KAP survey. The advantage of using this model is the collection of large amounts of data in a single survey that is analysed to compliment what qualitative data would have failed to gather. When giving the outputs for 2015-2017 data were quantitatively gathered and later merged with other factors as established by the study. However, the KAP method is arranged in such a way that it enables collection of both quantitative and qualitative data using the same questionnaire.

The KAP model shows the relationship between knowledge, attitude and practice (skills). It aims at telling the researcher what people know, how they feel and how they behave. In essence the model tries to answer how, where and when the farmer training sessions were conducted. It concludes by suggesting an intervention of specific circumstances to plan as required by the situation. Therefore, in this study KAP helps in measuring the known situation in relation to farmer training approaches and then improve the existing framework or seek an alternative farmer training approach for better yields in the irrigated maize schemes in Mashonaland Central Province that are deemed to be below capacity.

3.6 Analytical tools

Data were analysed using thematic analysis, descriptive (bar graphs, mean, and percentages), Chi-square test, t-test, the linear regression model, the ordinal logistic analysis. Thematic analysis was used to analyse qualitative data using themes and to support quantitative analysis. Descriptive statistics was used to understand the demographic characteristics and the difference between different indicators such as type of farmer training, training approaches offered to farmers, field training in the three irrigation schemes, farmer choice of training methods, among other aspects, while the Chi-square test was used to analyse the relationship between two categorical values. The independent sample t-test was used to analyse the relationship between a categorical dependent variable (Yes/No) and an independent variable that is continuous. The linear regression model was used to analyse the

effect of farmer skills on maize yield while the ordinal logistic/ordered logic regression model was used to analyse the effect of training methods on the use of crop production technologies.

Multiple linear regression analysis

The linear regression model is used to analyse the relationship between a continuous dependent variable and independent variables. Several studies have used the multiple regression analysis in studying the determinants of maize production (Nathan *et al.,* 2019). The key assumption of the multiple linear regression model is that the dependent variable must be normally distributed. However, the study did not run the normality test based on the assumption that as the sample size increases normality test becomes less important (Ghasemi & Zahediasl, 2012). The dependent variable for the multiple regression model was average yield while the independent variables were farming as a business, knowledge and self-reliance, record keeping, viability assessment, pest management, timely harvesting, post-harvesting management, cattle manure use, inorganic and organic fertilizer and compost use. The regression model can be specified as spelt out in (Gujarati, 2004).

$$Y_i = \beta_0 + \beta_1 X_1 + \cdots . \beta_n X_n + e$$

Where Y_i if the dependent variable (climate change adaptation index)

$\beta_0$is the intercept

$\beta_{1-n}$is the regression coefficients to be estimated

$X_1$are the independent variables

e is the error term

The ordinal regression analysis

Ordinal Logistic Regression was used to establish specific preference differences. The ordered regression model was mostly used when the dependent variable is ordered in a natural way and independent variables. In this case the dependent variable is training methods with 4 categories i.e., those that use one training approach, 2 approaches, 3 approaches and 4 approaches and the independent variables includes, household size, landownership, age of the household head, educational qualification, marital status and agricultural training. The ordinal regression model can be expressed as spelt out in Abdullah et al., (2021):

$$logit\left(P(Y \leq j)\right) = \beta_{j0} + \beta_{j1} X_1 + \beta_{j2} X_2 + \cdots \ldots . . \beta_{jn} X_n$$

Where;

j = 1……. j-1;

n = predictors

β_{j0}= constant/intercept

β_{j1} …….. β_{jn} = coefficients

This model can be specified as

$$logit\left(P(Y \leq j)\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots \ldots\ldots \beta_n X_n =$$

$$\beta_0 + \beta_1 \text{household Size} + \beta_2 \text{Land ownership} + \beta_2 Age\ of\ household\ head$$
$$+ \beta_3 Educational\ qualification + \beta_4 Marital\ status + \beta_{5Agricultural\ training}$$

3.7 Data analysis

Data were cleaned by performing frequencies analyses on each variable to see if there were any that had values outside the possible range. Statistical Package for the Social Sciences V20 (SPSS) was used. This is the best tool to analyse qualitative data obtained through KAP surveys. The survey strived to collect available data to determine if knowledge, attitudes and practices of a community have changed over time. Frequency distributions were used to describe the basic features of the data collected during the study. Statistical significance was considered at $P < 0.05$.

Table 3.1: Analytical Framework

Table 3.1: presents the objectives, type of data required and methods of analysis.

Objective	Type of data required	Method of Analysis
To identify the key learning domains for effective use of irrigation technologies in smallholder maize farming in Mashonaland Central Province.	Primary data	KAP Approach
To improve a training approach that is tailored to the identified learning domains and the specific needs and constraints of smallholder farmers in Mashonaland Central Province.	Primary data	Descriptive statistics
To evaluate the impact of the improved training approach on the productivity and income of smallholder maize farmers in Mashonaland Central Province.	Primary data	KAP Approach
To assess the effectiveness of the improved training approach in improving the knowledge and skills of smallholder farmers in the use of irrigation technologies for maize farming.	Primary Data	Descriptive statistics

3.8 Ethical Considerations

After successful presentation and approval of the proposal to the School of Agriculture a letter clearing the research to be undertaken was received from the University of Venda Research Ethics Committee. The ethical clearance letter was presented to the Ministry of Agriculture Lands Fisheries Water and Rural Development (MALFWRD) requesting for the researcher to be granted access into Mashonaland Central. Approval and permission to conduct research was then granted by the Ministry. Thereafter, a reconnaissance visit was undertaken to the study area for ground truthing. It presented an overview of the study area and opportunity to seek permission from the traditional leaders and the political hierarchy to undertake the study. The Extension Officers then introduced the researcher to the schemes' Chairpersons, political and traditional leaders of the areas.

A social orientation meeting was then organised for the following day in Chimhanda first. The meetings were held at different days as three schemes were involved. The meetings were held with the two Extension officers at Chimhanda, and 2 at Negomo, Stakeholders were informed of the survey and its intended purposes. As argued by Bryman & Bell (2007) and Wagner *et al.*(2012), there are ten principles to be considered when one is about to undertake research. As per the principles, all the respondents were educated on the purpose of the survey and the intention of sharing the results with the respondents upon the completion of the study. The respondents were not coerced into giving answers, but consent was sought first through their representatives. In line with the informed consent principle, participants were given detailed information regarding the research purpose, objectives, procedures for data collection and benefits of the research and the aspect of confidentiality. Confidentiality included the assurance to participants that all the information they provided was only for academic purposes. It was also highlighted that they were free to withdraw from participating in the study at any time during the research process.

The questionnaires were not discriminatory and in no way was any party offended. All sources of literature were acknowledged through the referencing section to avoid plagiarism. As argued by Shamoo & Resnik (2009), credit should be given where it is due in as far as acknowledging data are concerned. The researcher did not falsify or exaggerate data that was used in the study. Mashonaland Central is a highly political charged area, therefore, all protocols were observed so that the researcher was not suspected of any political affiliation.

3.9 Conclusions

This chapter presents the mixed methodology used to gather data. Both quantitative and qualitative methodologies were applied in the determination of the involvement of cognitive, affective and psychomotor learning domains in the training of irrigated maize farmers in Negomo, Eben and Chimhanda Schemes. People are born with different learning capacities hence these should be considered. Thus, making learning important as no one was born with competencies, but all were learnt. The literature review indicates that irrigation schemes in the country but with reference to Mashonaland Central Province were not performing as expected. Thus, justifies the critical element to assess the causes of the poor performance as to whether it was training related or other socio-cultural-economic factors affecting maize production. Various data gathering tools and techniques were employed to come up with an improved training framework for increased maize productivity in the irrigation schemes.

CHAPTER 4: DESCRIPTION OF RESEARCH RESULTS

4.1 Introduction

In this chapter, the results of the study on the four objectives are presented. Results are presented for each of the key research questions. Demographic characteristics of farmers engaged in the schemes are presented. Criteria for assessing effectiveness of training farmers involved in irrigated maize farming, their perception on the effectiveness of training approaches currently on offer on improvement of irrigated maize farmer performance are presented. Results on the elements on the development of current training framework are also presented. Lastly, is the presentation of the assessment of the level of skills possessed by farmers in the schemes.

4.2 The key learning domains for effective use of irrigation technologies in smallholder maize farming in Mashonaland Central Province

4.2.1 Demographic characteristics of sampled farmers

Table 4.1 presents the household characteristics of farmers participating in irrigated maize farming in Chimhanda, Eben and Negomo Irrigation Schemes. Results show that household headship in the three irrigation schemes was male dominated with more than 84 %, 88 % and 64 % male headed household in Chimhanda, Eben and Negomo Irrigation Schemes respectively. The majority (28 %) of farmers participating in Chimhanda Irrigation Schemes were between 56 and 65 years of age followed by those that were above 65 years (25 %) of age (Table 4.1). Only 2 % of farmers participating in Chimhanda Irrigation Scheme were less than 26 years. Among farmers participating in Eben Irrigation Scheme, the majority (38 %) were between 36 and 45 years followed by about 19 % who were aged between 56 and 65 years old with about 12 % of the farmers participating in the irrigation scheme above 65 years of age and no household participating in Eben Irrigation Scheme was less than 26 years old.

The majority (27 %) of the households participating in Negomo Irrigation Scheme were aged between 56 and 65 years followed by 26 % who were aged between 46 and 55 years of age with only 1 % aged less than 26 years. Notably the sample size was dominated by households aged between 56 and 65 years (Table 4.1). The low numbers of young farmers under 25 years of age is due to the timing of the establishment of the irrigation schemes. The average

household families were 6 in Chimhanda and Eben Irrigation Schemes and 5 in Negomo Irrigation Scheme. There was a significant relationship in the size of the household among maize farmers in the three irrigation schemes which was significant at 5 % level. This means that within the three groups of irrigation schemes there are some groups which have different sizes of households. The multiple comparison test using the Least Significant Difference (LSD) test shows that there was a significant difference between maize farmers irrigating in Negomo and Chimhanda which was significant at 1 % level while there was also a significant difference between maize farmers which were irrigating in Negomo Irrigation Scheme and Eben Irrigation Scheme which was significant at 5 % level Table 4.1. Most of these farmers relied on farming as a source of income. Others highlighted that cross-border trading, building and paid employment, were other sources of income besides farming.

In terms of marital status, 82 %, 92 % and 67 % of the participants in Chimhanda, Eben and Negomo Irrigation Schemes were married household heads, respectively. Thus, the three irrigation schemes were dominated by married household heads followed by widowed farmers. Surprisingly no men indicated that they were widowers. About 46 % of farmers participating in Chimhanda Irrigation Scheme had modest education up to secondary education followed by 26 % who had primary education. The majority (36 %) of farmers in Eben Irrigation Scheme were schooled to primary education followed by 32 % who attained at most standard 6 or ZJC. About 50 % of farmers in Negomo Irrigation Scheme were schooled to secondary education followed by 26 % who were schooled to primary education. Notably, the three irrigation schemes were dominated by farmers educated to secondary education (45 %). The second largest number attained primary education. There was a statistical significant difference in the level of education between farming households participating in the irrigation schemes which was significant at 5 % level.

Table 4.1: Demographic characteristics of Chimhanda, Eben and Negomo Irrigation Schemes

Variable		Irrigation			All participants total n=208	P values
		Chimhanda n=63	Eben n=26	Negomo n=119		
Sex (%)	*Female*	16.39	11.54	35.90	26.96	0.003
	Male	83.61	88.46	64.10	73.04	
Age (%)	*Less than 26*	1.64	0	0.86	0.99	0.142
	26 – 35	14.75	15.38	6.03	9.35	
	36 – 45	11.48	38.46	19.83	19.70	
	46 – 55	19.67	15.38	25.86	22.66	
	56 – 65	27.87	19.23	26.72	26.11	
	66+	24.59	11.54	20.69	20.69	
Marital	*Single*	1.64	0	4.24	2.93	0.173
status (%)	*Married*	81.97	92.31	66.95	74.63	
	Divorced/Separated	0	0	2.54	1.46	
	Widowed	16.39	7.69	24.58	20.00	
	Never Married	0	0	1.69	0.98	
Education	*Primary*	24.59	36	25.64	26.60	0.038
(%)	*ZJC/standard 6*	16.39	32	20.51	20.69	
	Secondary	45.90	24	49.57	45.32	
	Tertiary	6.56	0	3.42	3.94	
	Degree	4.92	0	0	1.48	
	Other	1.64	8	0.85	1.97	
Household size (mean)		5.9	5.96	4.9	5.33	0.016

significant at 10% level and significant at 5% level

4.2.2 Shelter and sanitation facilities

All farmers who participated in the survey had brick houses with the majority (72 %) having asbestos sheets as roofing materials. Farmers with only grass thatched houses constituted (7.2 %). Of note were 1 % of the householders who had brick under tile houses. The state of farmer livelihoods and their housing types reflects the effectiveness of irrigation schemes post-training programs. While training initiatives play a vital role, acknowledging the influence of broader government support, like input provisions, ensures a comprehensive evaluation of scheme performance.

On social networking, farmers in the three irrigation schemes reported that they either belonged to some farmer group or farming cooperative with church-based groups being the most participated by about 71 %, 73 % and 63 % of the farmers in Chimhanda, Eben and Negomo Irrigation Schemes respectively (Table 4.2). A few (about 25 %, 0 % and 24 %) in Chimhanda, Eben and Negomo Irrigation Schemes respectively indicated memberships to a burial society whilst others joined funeral service providers' schemes. There was a significant difference in participation in social groups such as women groups, village savings and lending schemes and farmer cooperatives which were significant at 1 % level while participation in burial societies was significant at 5 % level.

Table 4.2: Farmer participation in farmer groups in Chimhanda, Eben and Negomo irrigation schemes

	Chimhanda (n=63)	Eben (n=26)	Negomo (n=119)	P values
Burial society (%)	25.4	0	24.4	0.016
Church (%)	71.4	73.1	62.7	0.376
Women groups(%)	11.1	3.8	0.8	0.005
Village Savings and Lending Schemes (VS&LS) (%)	41.3	26.9	4.2	0.000
Farming cooperatives (%)	15.9	0	98.3	0.000

significant at 1% level and significant at 5% level

4.2.3 Training approaches offered to farmers in Chimhanda, Eben and Negomo Irrigation Schemes

Smallholder farmers in the three irrigation schemes received trainings through the Trainee Master Farmer, Master Farmer, Training of Trainers (ToT) and Farmer Field Schools between 2015 and 2017. Trainee Master Farmer training referred to those farmers who did not finish the Master Farmer training to get a certificate after completion of the training programme. The programme required the application of Bloom's Taxonomies of learning domains as examinations and practicals were instituted. The levels of farmers not trained increased as one moves from nearer town to the remotest scheme. Chimhanda Irrigation Scheme dominated in receiving skills through Farmer Field Schools (FFS) and Trainee Master Farmer training as compared to Eben and Negomo Irrigation Schemes (Table 4.2). Farmers participating in Eben Irrigation Scheme dominated in Master Farmer Training and ToT training of trainers as compared to Chimhanda and Negomo Irrigation Schemes. The difference in the trainings received by farmers in the three irrigation schemes was significant at 1 % level.

Table 4.3 Agriculture training offered in Chimhanda, Eben and Negomo irrigation schemes

Variable	*Eben (13%) n=26*	*Participants Chimhanda (30%) n=63*	*Negomo (57%) n=119*	*All participants (100%) n = 208*	*P values*
Trainee master farmer	*24*	*35.56*	*32.17*	*31.89*	*0.10*
Master farmer	*28*	*22.22*	*26.96*	*25.95*	
Training of trainers	*20*	*6.67*	*3.48*	*6.49*	
Farmer field school	*8*	*35.56*	*18.26*	*21.08*	

significant at 1 % level and significant at 5 % level

4.2.4 Types of training received in Chimhanda, Eben and Negomo Schemes

Figure 4.1 presents the types of training received by farmers participating in irrigated maize production. Results show that most farmers participating in the three schemes received training on pest management, post-harvest knowledge, water management and farming as a business. Farmers in Chimhanda Irrigation Scheme received training on pest management, post-harvest management and farming as a business followed by those that received training on water management. Farmers in Eben Scheme received training on bookkeeping, water management and farming as a business followed by those that received training on pest management and post-harvest management. In Negomo Irrigation Scheme, most farmers received training on pest management followed by those that received training on post-harvest management.

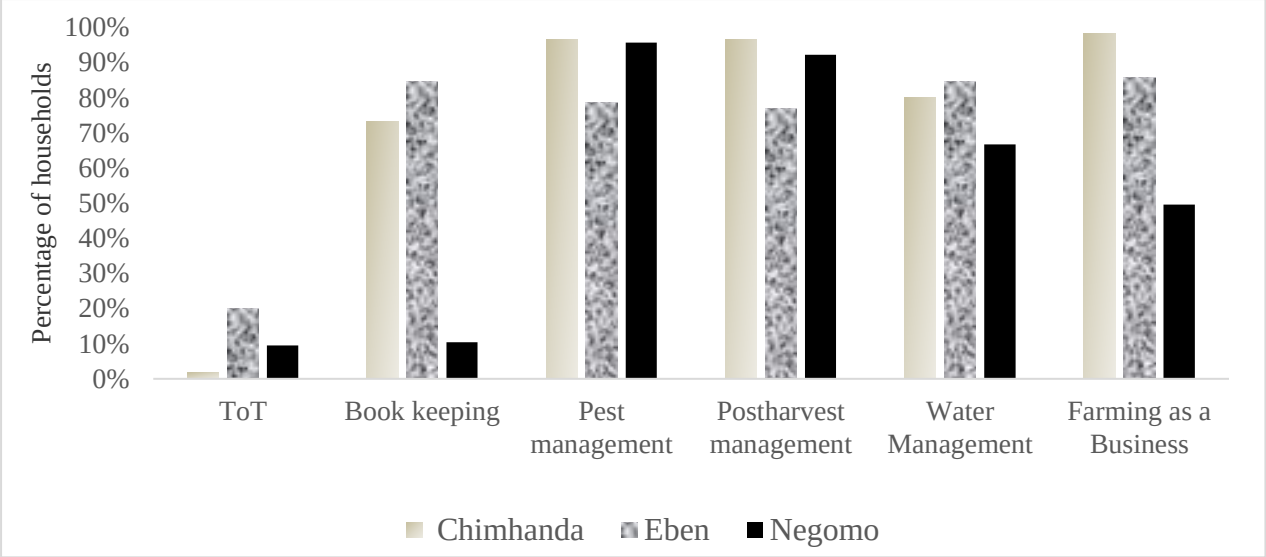


Figure 4.1: Types of training received in Chimhanda, Eben and Negomo Irrigation Schemes

4.2.5 Sources of training in Chimhanda, Eben and Negomo Irrigation Schemes

The results in Figure 4.2 indicate the range of sources of trainings offered to irrigated-maize farmers. Most farmers acknowledged ARDAS as their source of training for all types of needs. This was followed by NGOs such as the Zimbabwe Farmers Union, Lead Farmer, Community Technology Development Trust and Ruzivo Trust who offered farmers training on Training of Trainers (ToT) in Negomo, bookkeeping, water management and farming as a business more than ARDAS. However, of note is the low number of partakers of the bookkeeping trainings (Figure 4.2). Participants expressed dissatisfaction with the trainings citing difficulties in comprehending the information while others highlighted that it was not easy to follow. Most of the stuff was theory and there were no practicals.

Extension officers used lecture method as an instructional method. Practicals were sometimes not done or were performed on individual fields during the next planting season. This then, depended on the level of education for one to relate with actual practice. One farmer had this to say in relation to theory then practicals.

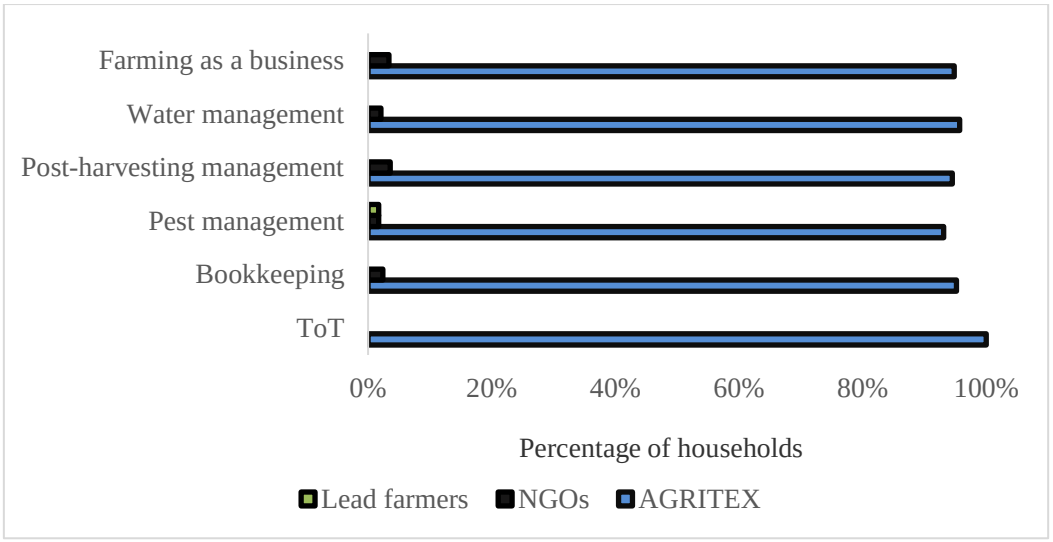
> "*We were taught and assume that we have grasped the information, but later fail when trying to put into practice because we will have forgotten. We end up resorting to our old ways of doing things. Sometimes lessons are done but by the time inputs are delivered we will have forgotten the learnt material."*

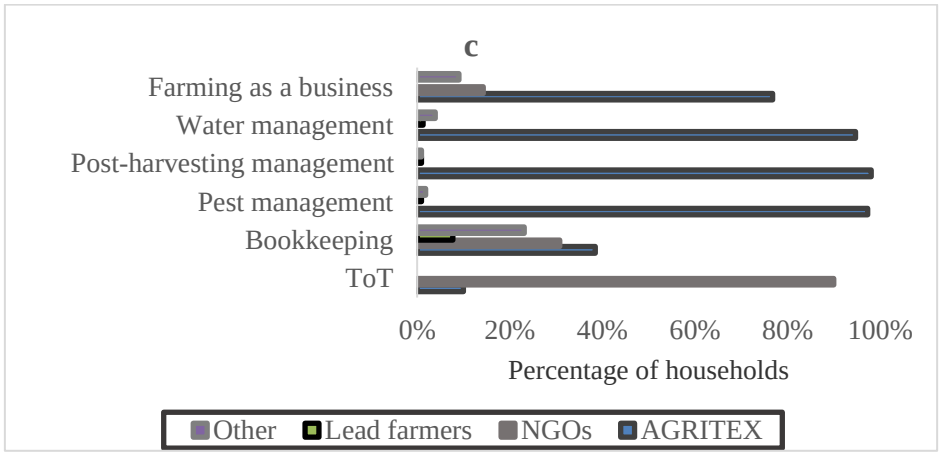
4.2.6 Indicators of adequacy of agricultural training

When communities adopted recommended agricultural practices there is realisation of increased production. Results in Table 4.3 show the content offered to farmers involved in irrigated maize farming. Pest management training and post-harvest management had a high number of participants of 81% and 77 % respectively. Water management showed attendance of 59 % farmers. Training of trainers (ToT) was conducted and of the three smallholder irrigation schemes, only 6 % members indicated attendance. Various trainings offered to irrigated-maize farmers during the period 2015-2017 are as indicated in Table 4.3. Members showed keen interest in most of the courses offered except for bookkeeping (27%) farmer participants.

Table 4.4: Content of training offered to farmers during the period, 2015-2017

Training area	Number of farmer participants			
	Eben (%)	Chimhanda (%)	Negomo (%)	p-values
Training of trainers (ToT)	20	1.8	9.5	0.1
Bookkeeping	84.6	73.3	10.4	0.000
Pest management	78.6	9.7	95.7	0.018
Post-harvest management	76.9	96.7	92.2	0.047
Water management	84.6	80	66.7	0.103
Farming as a business	85.7	98.4	49.9	0.000





a=Chimhanda; b = Eben and c = Negomo Irrigation Schemes

Figure 4.2: Fields of training in Chimhanda, Eben and Negomo Schemes

4.2.7 Participation and duration taken to complete training

The duration of training sessions varied from weekly to fortnightly for pest and water management, and once a year for other courses. Most farmers attended 1-day trainings as reflected by the number of participants in pest management (71 %), post-harvest management (68 %) and water management (53 %) training. Farming as a business is a new program introduced into the agricultural system. Other farmers preferred 1 week to train farming as a business (16 %), Training of Trainers (4 %) and pest management training (6 %).

4.2.8 The effect of training methods on the use of improved crop production technologies in Chimhanda, Eben and Negomo irrigation schemes

The ordinal or ordered logistic regression analysis on factors that affect the uptake of technologies such as new seed varieties, fertilisers, pesticides, organic manure and others show that the model was significant as shown by the likelihood ratio of 37.96 with a chi-square statistic of 0.0001 that is significant at 1% level as compared with the null hypothesis with no predictors (Table 4.4). This means that at least one variable in the model is not equal to zero. Total land owned by a farmer, educational qualification, marital status, and agricultural training obtained significantly influenced adoption of technologies.

Total land owned by a farmer had a coefficient of 1.97 and significant at 1 % level. This means that a 1- unit increase in total land owned by a farmer result in 1.97 increase in the log-odds of adoption of technologies given all other variables in the model are held constant respectively. Master farmer training was significant in the category of agricultural training with a coefficient of 1.17 and significant at 1 % level relative to the base category of not receiving training at all. This means that a 1-unit increase in training among farmers in the irrigation schemes results in a 1.17 increase in the log-odds of adoption of technologies given other factors in the model are held constant. Having a Master Farmer certificate also influences adoption of technologies in the category of agricultural trainings with reference to the base category of not receiving any training at all. Having a Master Farmer training has a coefficient of 1.03 and it was found to be statistically significant at 1 % level. This means that a 1-unit increase in training result in a 1.03 increase in the log-odds of adoption of technologies in the irrigation schemes. Thus, farmers who receive master farmer training are more likely to adopt technologies.

Farmer Field Schools (FFS) was significant in the category of agricultural training relative to the base category of not receiving training at all. Attaining FFS training had a coefficient of 1.62 which was significant at 1 % level. This means that a 1-unit increase in farmer participation in Farmer Field Schools resulted in a 1.62 increase in the log-odds of adoption of technologies given other factors in the model are held constant. These results suggest that the more a farmer receives training will result in an increase in adoption of technologies for improved production.

Being divorced was significant (Table 4.4) in the category of marital status relative to the base category of being single. Being divorced or widowed has a coefficient of -2.73 and significant at 5 % level. This means that a 1- unit increase in divorced or widowed households will result in a 2.73 decrease in the log-odds of adoption of technologies given other factors in the model are held constant. Educational level of the household heads has a coefficient of 0.24 and significant at 10 % level. This means that a 1 - unit increase in the level of education result in a 0.24 increase in the log-odds of adoption of technologies given other factors in the model are held constant. This means that the more a farmer has formal education the more they are to adopt the promoted technologies. Household size was also significantly affecting adoption of technologies and was significant at 10 %. This means that a 1- unit increase in the size of the household results in a 0.07 decrease in the log-odds of adoption of technologies. Household members are, therefore, important aspects in the provision of labour and decision making.

4.2.9 Farmer selection for agricultural training

In the study farmers were asked to indicate how selection for farmer training was conducted. The trainings were however, not organised as spelt out in the gender or age but for all members involved in the irrigation schemes. The variables were age, gender, plot holders, political or volunteers. From the findings 95 % of the participants indicated that trainings were offered to plot holders while others volunteered to participate in the training programmes. As part of the training package, there were field days in which farmers were visiting successful farmers and learn from them. However, access to information about the trainings was skewed as some plot holders did not even know that there were training sessions that were held in the schemes. These plot holders participated in the survey thinking it was government assistance related. In addition to that, farmers faced transportation challenges to travel to the successful farmers.

4.2.10 Adoption levels of new technologies and innovations by farmers in Chimhanda, Negomo and Eben Schemes.

The results revealed that 20 % of the participants had fully adopted new technologies and innovations followed by 63 % of the farmers who had partially adopted whilst 8 % indicated that they had not yet adopted but willing to adopt.

4.3 Assessing the Perceived Effectiveness of Current Training Approaches on Irrigated Maize Performance

4.3.1 Current training approaches in use for irrigated maize farmers

Figure 4.3 highlights the approaches that are currently employed to the irrigated maize farmers. The study results from Figure 4.4 revealed that most of the farmers engaged in the FFS (89.72 %) approach and Field Day approach (88.29 %).

4.3.2 Farmer choice of approach

Farmers were asked to indicate the training approach they considered best. The findings showed that 42 % of the participants preferred Master Farmer Training followed by 31 % who preferred Field Days while 27 % preferred Farmer Field Schools. Innovation platforms had the least ranking of preference. Training approaches used at Negomo were discussion, agricultural shows, demonstrations, field days and tours. Farmer field school was engaged for instance when farmers were touring a mango production field that had been done by one farmer. This was an innovation that most farmers had not thought of. Although participants, highlighted resuscitation of MFT, one extension officer respondent highlighted that the approach needed revision as it had its weaknesses. Some of the components were no longer applicable in today's agricultural practice. Some of the extension officers interviewed, thought demonstrations, tours and field days were the best approaches to be used for adult learners in the schemes.

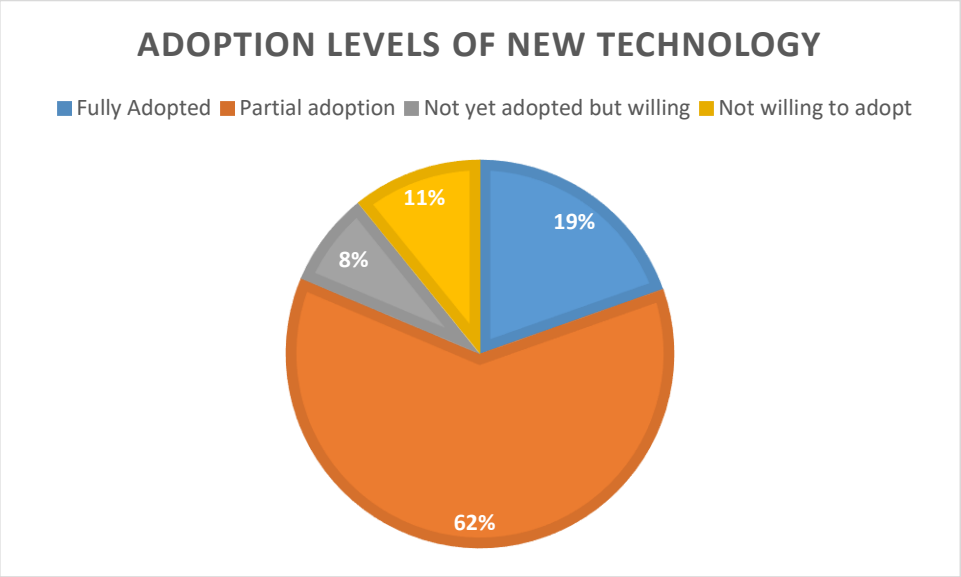


Figure 4.2: Adoption of new technologies

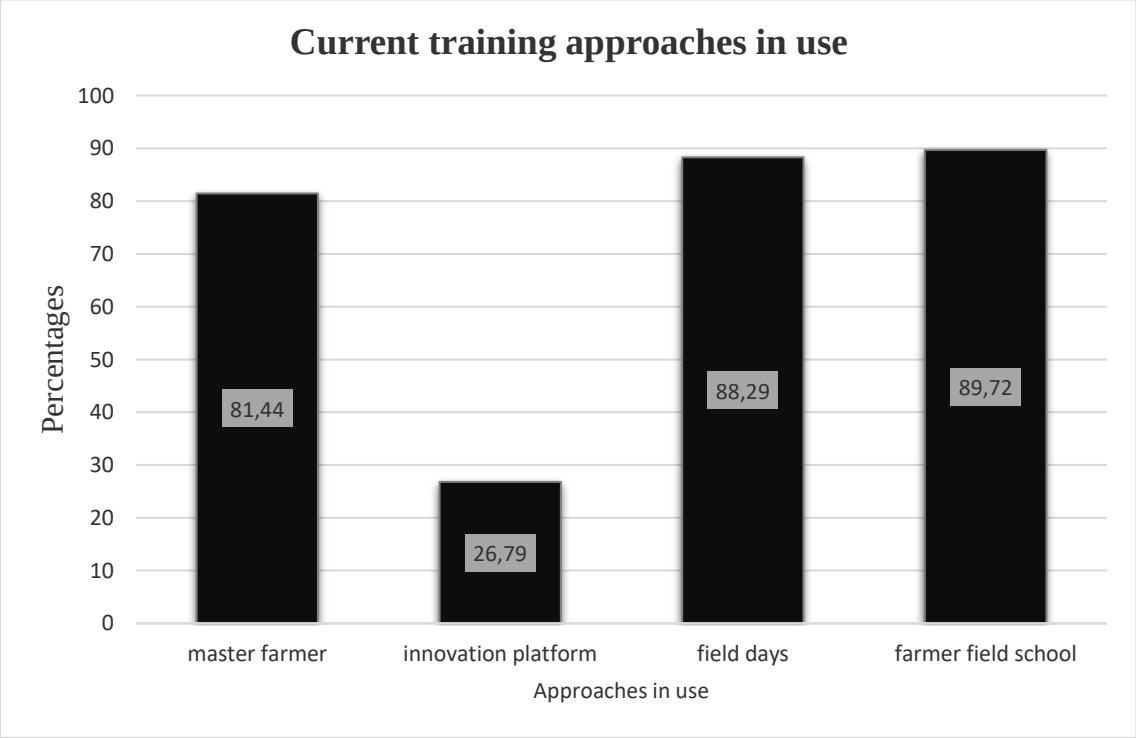


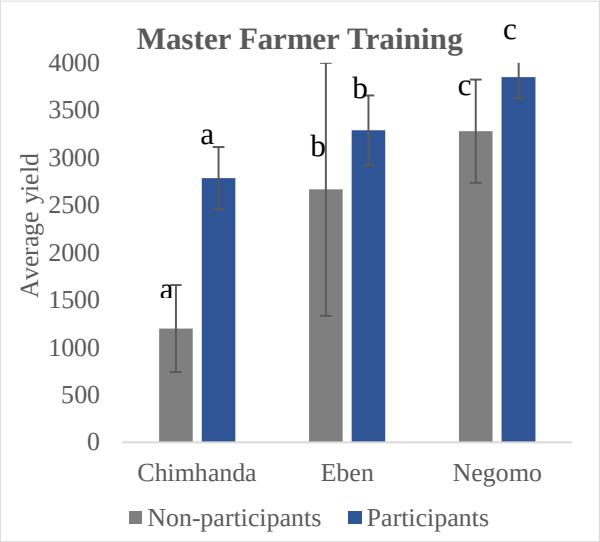
Figure 4.3 Types of training approaches used by farmers in irrigation schemes

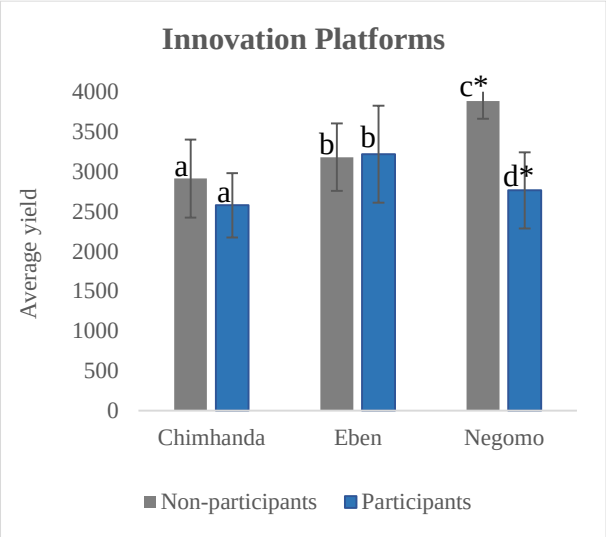
4.3.3 Crop Production 2015-2017

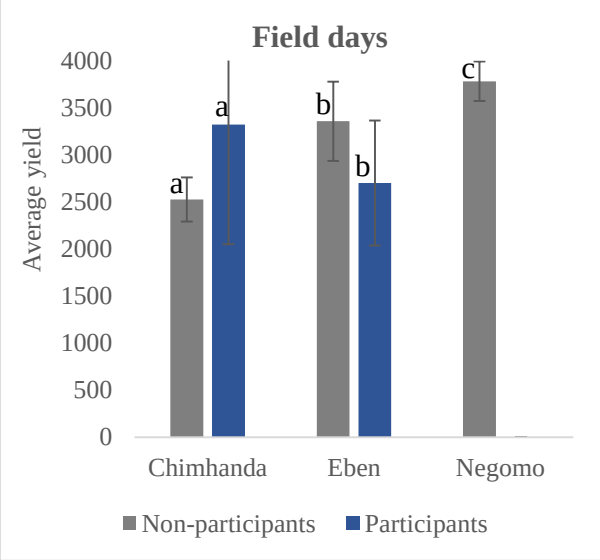
The results from the independent sample t-test (Figure 4.4) show the effect of training on maize yields per each irrigation scheme. The results show that there was a significant difference in the average yield among farmers who participated in innovation platforms in Negomo Irrigation Scheme which was significant at 10 % level. In this case, farmers who were not participating in innovation platforms attained higher yields as compared to those that attended the innovation platforms. There was no significant difference in the average yield per hectare to farmers who received Master farmer training, innovation platforms in Chimhanda and Eben Irrigation Schemes, filed days and farmer field schools. Notably, farmers in Negomo Irrigation Scheme were not doing field days while farmer field schools were not used in Chimhanda and Eben Irrigation Schemes.

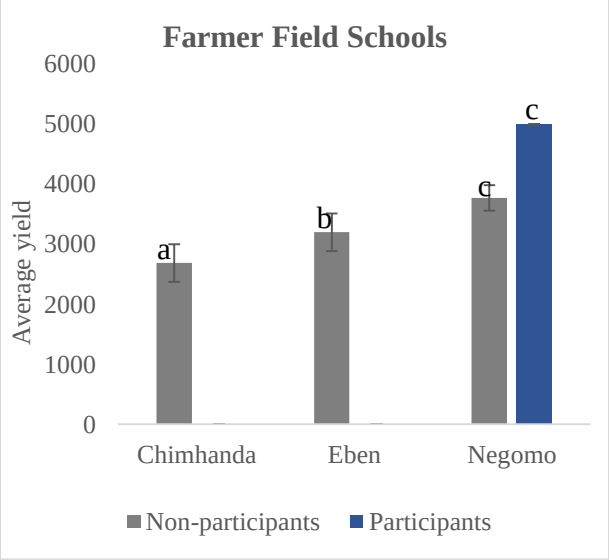
Rating of crop production was done, and results indicated that 45 % of participants highlighted that crop production was very good after training. This result is an indicator that most farmers fully comprehended what was being delivered either during lecture periods, demonstration or field days. The good rating was indicated by 40.7 % of the participants. The results of satisfactory, poor and very poor were represented by 12.2 %, 1.6% and 0.5 % respectively. These ratings are attributed to low levels of education or not valuing the messages delivered to them to put into practice what was learnt. Some farmers indicated that they had never attended a single training session, yet they were plot holders. The low levels of production that were indicated by some farmers were because of old age hence could not work on the plot. Some cited ill health and lack of inputs, lack of labour and the fall armyworm.

In the Province initially yields were 1.5-2 tonnes per 1.5ha plot. Farmers were growing own varieties. With the coming of Command Agriculture farmers were provided with improved varieties and inputs. Yields increased to 4 tonnes. Due to this increase in production, most households afforded an average of 2 to 3 meals per day consisting of the staple food sadza taken with various relishes. It is unfortunate that most families failed to have diet variations due to the average income obtained after harvest and paying back the grain loans.









= Size of household; = training acquired and = Household income per annum.

Figure 4.4: Crop Production 2015-2017

Water management system at the scheme also caused problems as the sprinklers were not working and members ended up irrigating at unscheduled times resulting in conflicts. When asked why the IMC or members fail to control the watering pattern, one participant had this to say:

> *"We cannot question why they continue poaching water because some of them are leaders and for fear of being bewitched."*

Sugar beans were in abundance at Chimhanda. Access to good marketing facilities was a challenge to the farmers. It was found out that the Agricultural Marketing Authority (AMA) of Zimbabwe had visited the area training farmers on viability and promised to link the farmers to agro-dealers so they could get buyers but nothing had materialized at the time the study was conducted.

4.4 Adoption of Innovation and Skills of Farmers Involved in Irrigated Maize Farming

4.4.1 Farmer perception on skills and knowledge acquired through training and their effect on adoption of innovations

Figure 4.5 show skills obtained through different training regimes. In Chimhanda, all (100 %) of participants received pest management skills followed by those that received post-harvest management technologies. In Eben Irrigation Scheme, 94 % of farmers received training on pest management, timely harvesting, post-harvest management, use of compost, cattle manure and use of both organic and inorganic manure (Figure 4.5). This was followed by those that received skills on farming as a business and self-reliance. In Negomo Irrigation Scheme 93 % of respondents received skills in pest management followed by those that received skills in farming as a business. Pest management had the highest frequency of farmer attendance in all schemes as participants required knowledge and skills to eradicate the problem of armyworm and fall armyworm that prevailed during that season. Pest management is followed by the post-harvest management and concerning this training farmers had a problem of large stalk borer that was even attacking the maize in the field before storage. Farming as a business and Record keeping also got a fair portion of attendance. Timely harvesting, use of cattle manure and compost use skills when synchronised facilitates the use of stalks from harvested maize to make compost and alternatively feed their cattle to get cattle manure to use in the next batch of crop. Viability assessment, self-reliance and use of organic and inorganic fertilisers are other skills that add to better decision making and farm management practices for profitable returns.

Farmers also highlighted that the skills imparted by the extension officers were of value to maize farming. In all the schemes most (80 %) participants indicated that they partially remembered. Minority (20 %) highlighted that they totally failed to recall the taught information to put into practice when working on their fields because of the technical jargon involved. An assessment was then made to establish what participants know and what they intended to know. This is where the KAP survey was employed as farmers indicated gaps in good agricultural practice. The survey also tried to unravel the trainings that were attended and why those sessions were favoured most.

Of the various trainings attended by farmers in the three smallholder schemes, the results were indicative of major participation in highly favoured courses. Pest management (95 %), post-harvest management (91 %) and farming as a business (85 %) representation. Currently farmers have been enlightened on the issue of migrating from subsistence farming to farming as a business for better livelihoods and to be food secure. Thus, participation in the other two trainings as mentioned was to ensure that good harvests are realised. The number of farmers who attended the trainings that dominated reinforces the results of skills possession as indicated in Figure 4.5.

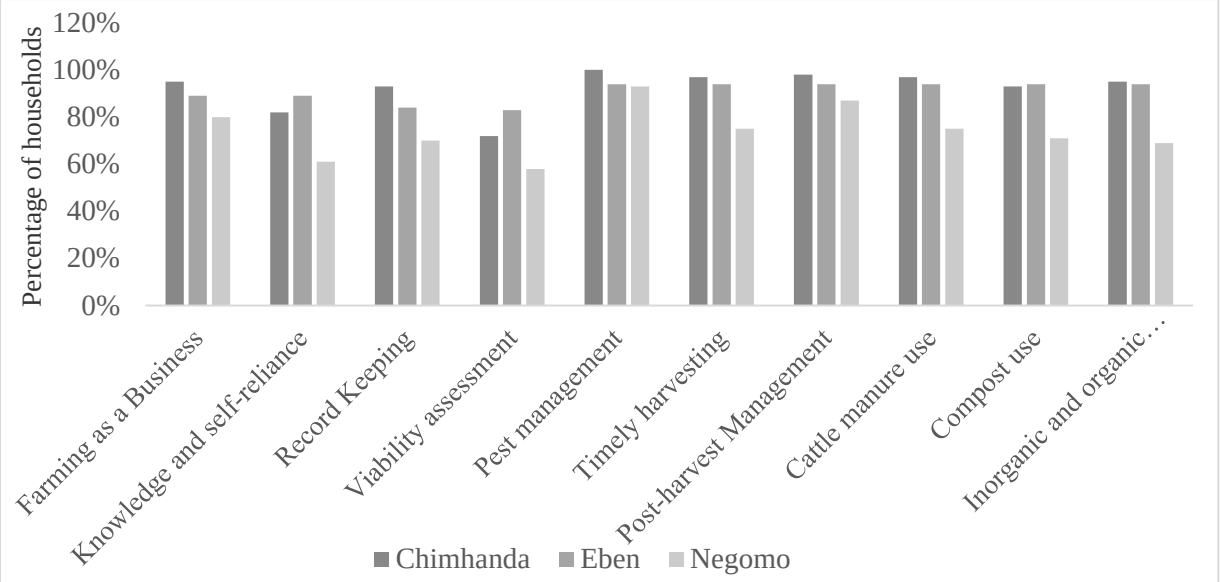


Figure 4.5: Farmers' skills and knowledge acquired through training

4.4.2 Farmer's perception on the importance of skills acquired on maize production

The study revealed that in Chimhanda Irrigation Scheme farmers had adopted the new practices at the right time thereby confirming the applicability of the affective domain that makes people change behaviour. Thus, irrigated maize farmers' level of skills was evaluated for this purpose. Marketing strategies were lacking in the farmers. Members resorted to local sales. Delivery of produce to Mbare Musika, the largest market in the country was established with the help of Agricultural Marketing Authority of Zimbabwe (AMA) rather than for farmers to continue relying on local sales. However, the venture was hampered by lack of affordable transport. It was expensive for an individual to hire transport to deliver the produce. On the other hand, there were barriers to marketing and selling as lamented by one upcoming young woman farmer on the issue of market linkages on the national radio broadcast Zimbabwe Broadcasting Corporation on 11 March 2020 that:

> "*Buyers have no confidence in new suppliers therefore it is very difficult to penetrate the market. One must go through middlemen otherwise products will perish considering that I am into horticulture."*

In the assessment of the level of farmer skills and knowledge, food security status in households and livelihoods are major indicators of well received training that was examined. Litter pits were also good indicators of availability of food in the homes of participants. It was observed that in Negomo mostly the pits had some food leftovers as compared to Chimhanda and Eben areas. The study revealed that most families managed to have 2 to 3 meals per day. Domestic equipment such as scotch carts, bicycles, gas stoves, wheelbarrows, television sets, radios among others were acquired using farm proceeds. Also farm equipment like ploughs, hoes, watering cans, cultivators and harrows possessions were also good indicators of well received training though not everyone had the necessary tools to use in the fields. Some of the widowed and aged farmers fell short of the basic equipment. Mostly male headed families had most assets to use both in the home and the farm.

4.4.3 Expected farmer skills in irrigated maize farming

Some elements such as soil fertility management and water management were lacking in the training programmes offered to farmers in Chimhanda, Negomo and Eben Schemes of Mashonaland Central Province of Zimbabwe.

a) Irrigation water management skills

Although economic use of water is the backbone of irrigation farming, it was noted that most farmers did not have enough knowledge on this aspect. To this end, watering was inconsistent especially at Chimhanda. Centre pivot sprinklers were not functioning well resulting in water poaching by farmers as they failed to stick to watering timetables. This saw some crops wilting due to non-watering causing losses to farmers. Power cuts caused by non-payment of the accumulated ZESA and ZINWA bills fuelled the improper irrigating of crops. Individuals failed to share the scarce resource for the benefit of everyone.

Participants at the three schemes were also not taught on how to calibrate to have normal water levels for reduced water losses. Extension officers also highlighted that there was need for this kind of training. There was ample proof on the site of the interview as some farming equipment had not been assembled including a centre pivot that was lying idle at the scheme for two (2) years without being mounted at Chimhanda. The extension personnel were fully aware of the derelict equipment and no remedial action was taken. The least they could have done was to report the presence of such equipment to higher offices so that it could be attended to. This notion brings out the issue of skills of the extension officer and method of communication to the affected farmers.

Farmers participating in the three irrigation schemes perceived skills obtained through trainings to be in the category of important and very important. The perceptions have a significant impact on their decision-making systems pertaining allocation of resources and during crop production systems. Farming as a business and pest management were considered to be very important skills that should be offered to farmers (62 %). Of equal importance were timely harvesting (61%) and post-harvest management (60 %). Viability assessment was the least ranked. This could be attributed to lack of information on what viability entailed.

4.4.4 Adoption levels of agricultural innovations and technologies

Results highlighted that 26 % of participants had fully adopted the newly introduced technical innovations, with 64 % having partially adopted. Those who had not adopted but willing to adopt were represented by 10 % whilst 0.5 % represented those who were not willing to adopt the new innovations at all.

4.4.5 Adoption of skills and knowledge in Chimhanda, Eben and Negomo Irrigation Schemes

Ninety-eight (98 %) of farmers in Chimhanda Irrigation Scheme used skills and knowledge on viability assessment and cattle manure. This was followed by those that apply skills on pest management, farming as business, timely harvesting, post-harvest management and compost skills and knowledge (Figure 4.7). About 98 %, Eben Scheme farmers used skills on viability assessment, pest management, timely harvesting and post-harvest management followed by those that used farming as a business, cattle manure and inorganic and organic fertilisers' knowledge and skills. In Negomo Scheme, 86 % of the farmers used viability assessment followed by those that use timely harvesting and pest management.

4.4.6 Effect of farmer perception on adoption and use of skills and knowledge

As shown in Table 4.8, farmer perceptions have a significant effect on adoption and use of pest management information that was significant at 1 % level (Prob.>$F_{16,4}$ = 0.003), while farming as a business knowledge (Prob>$F_{10,4}$ = 0.037), knowledge about bookkeeping (Prob>$F_{12,4}$ = 0.015), knowledge on timely harvesting (Prob.>$F_{10,4}$ = 0.030) and knowledge of using cattle manure (Prob.>$F_{11,4}$ = 0.030) which was significant at 5 % level, although record keeping still realises few participants. Furthermore, farmer perceptions on skills and knowledge improved use of post-harvesting and compost use that was significant at 10 % level (Prob.>$F_{9,4}$ = 0.066).

Table 4.5: Proportions of farmers who adopted management practices and use various skills and knowledge

Practice	Satisfactory	Good	Very good	Poor	Neutral	Statistical significance
Farming as business	84	64	82	100	50	**
Knowledge of self-reliance	68	67	68	100	25	
Book-keeping	80	55	76	100	50	
Viability assessment	95	92	92	100	75	
Pest management	95	76	97	100	75	*
Timely harvesting	96	79	92	100	75	*
Postharvest management	91	76	92	100	75	*
Cattle manure use	91	72	90	100	75	**
Compost use	86	66	76	100	75	*
Inorganic and organic fertilizers	75	69	76	100	50	

Farmers in all the schemes studied perceived that timely harvesting, pest management, post -harvest management and use of cattle manure respectively, were important aspects that should be adopted. Knowledge of self-reliance had the lowest ranking of 68 % despite being one of the most important aspects if schemes were to succeed without waiting for donor or government assistance. However, all participants indicated that they were not utilising the skills in their farming activities. Results indicated that all aspects were relevant but others like organic and inorganic fertilisers were not statistically significant.

4.4.7 Required agricultural and technical skills of Extension Officers

Extension officers were asked on what they perceived to be the required agricultural and technical skills for EOs for effective agricultural extension. The skills enable personnel to have `hands on' and technical skills that are relevant to maize production. Government support was therefore necessary. All participants indicated that in-service training and retraining of Extension Officers was required as new developments were emerging in the agricultural field. Previously, EOs would be send to other countries that were successful like South Africa to see how extension work was carried out. Other stakeholders were also invited to train ARDAS personnel on various aspects for proper agronomic practices for proper and easy transmission of information to the farmers. New skills and knowledge were required for proper operation of new machinery introduced in the irrigation schemes through the Agricultural Engineering Department.

At Chimhanda, it was revealed that a new centre pivot was delivered but it was lying idle for two years without being mounted as no one was trained to do that including the EO. The key informants highlighted that computer skills were also necessary represented by 90 % respondents. To have updated information the extension workers needed to be computer literate in most agricultural related packages such as the Geographical Positioning Systems (GPS) and to be able to use the Real Time Weather Forecasts. Most extension officers used their personal phones to check for new information as there were no internet facilities. It was difficult to access necessary information without a state-of-the-art phone. It was noted that communication skills such as report writing, and general communication were also of importance. The parent Ministry was reported to have limited resources to cater for staff training and equipment. Participants recommended that there be resuscitation of exchange programmes in the country with officers visiting other provinces, districts, regional and international agricultural places. These tours to be arranged in places where production levels

are high. The following section gives highlights on results whether to change the current training framework or to improve it for effective maize production.

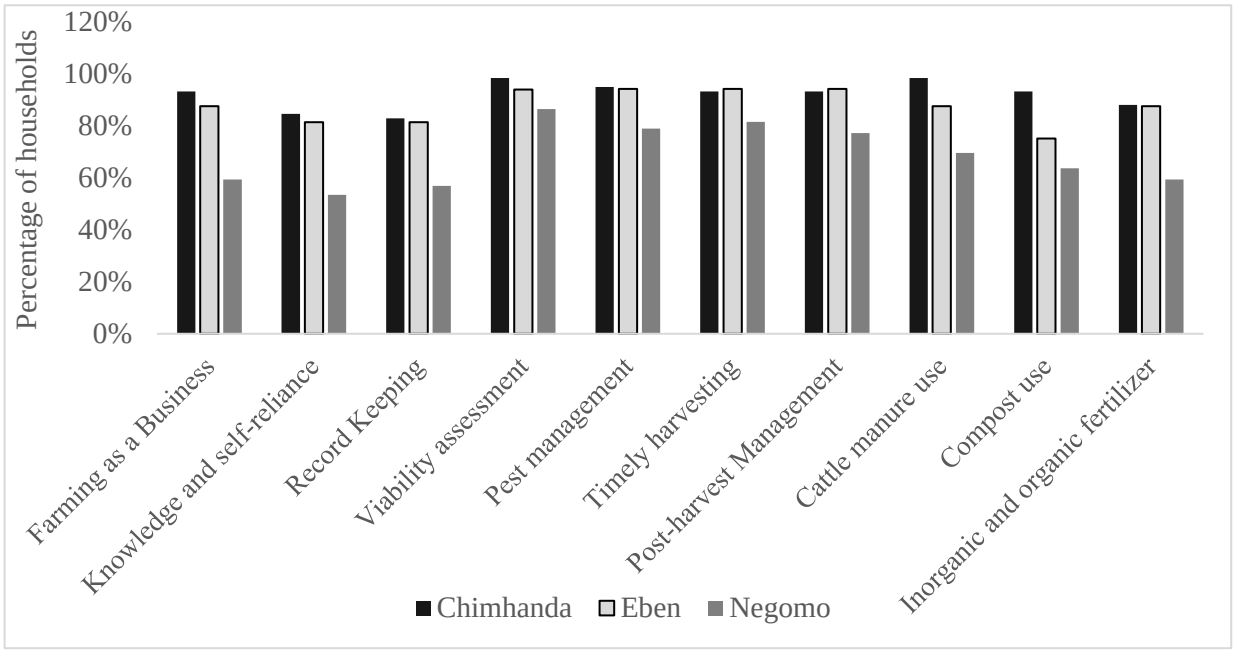


Figure 4.6: Skills and knowledge used in agricultural production

4.5 Ways of Improving the Current Training Framework

4.5.1 Most preferred delivery methods

Participants were asked to indicate the methods they preferred to get the best out of the training sessions. Table 4.5 and Figure 4.7 show the most preferred instructional methods in the irrigated maize farming in Negomo, Eben and Chimhanda Irrigation Schemes. Preference ranking was employed to determine the priority delivery methods by farmers. Demonstration was ranked the first by most of the farmers indicating that farmers choose to see actual processes as they happen first during practicals than theory during the training process. The lecture method was ranked the second and as seen from the results farmers ranked lecture on the first three ranks more often. Farmers wanted this form of training because it allows wide coverage of aspects. Most Farmers ranked working in groups on the third position as shown by 28 % respondents. This method mostly preferred as it enables synergism that affect positively on individual performance. Role playing was ranked 4thwith individual assignments ranked 5th.Drama and role playing had low rankings as there are people who generally want to ride on the work of others therefore would not want to be given an individual assignment.

One can conclude that most smallholder farmers in the three irrigation schemes preferred receiving information through demonstrations. When presented as single entities in Figure 4.8, the second most preferred delivery methods were groups and lectures for Eben and Negomo with some farmers in Negomo preferring individual assignments.

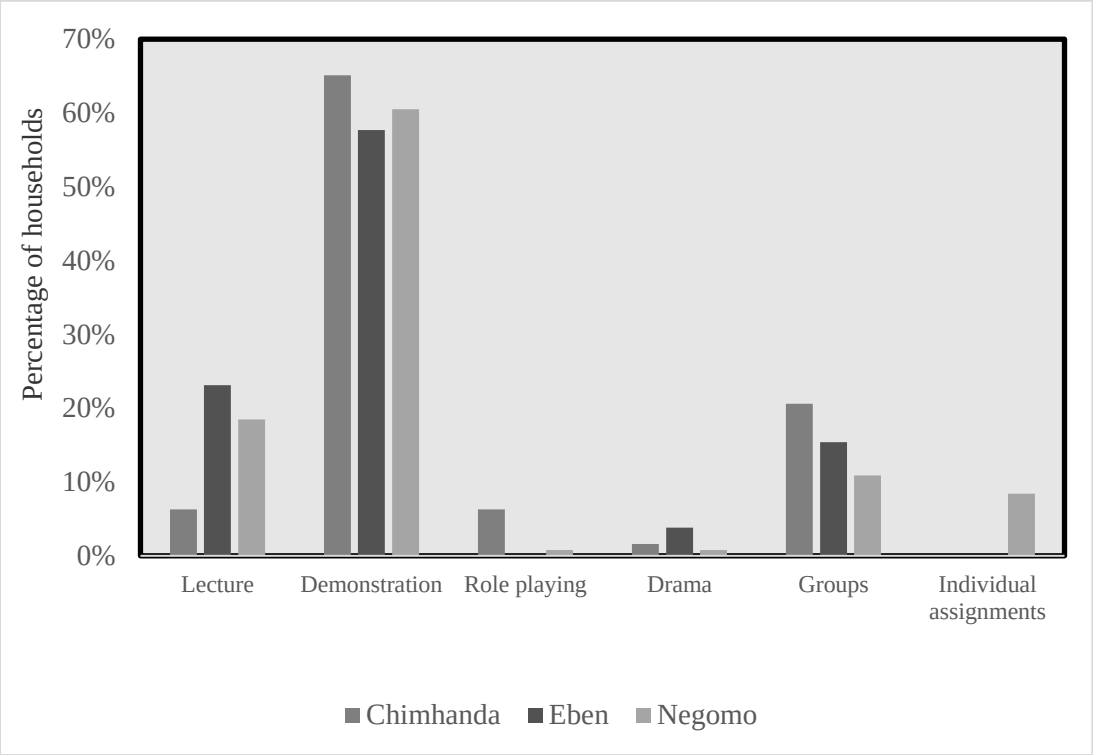


Figure 4.7: Instructional methods preferences

4.6 Summary

The farmer training programme is said to be adequate if there is relative change from old practices. This should result in participants managing to change their lifestyle because of new knowledge acquired and adoption of technologies and innovations. Farmer training focusing on various agronomic topics influences crop diversity and increases productivity. This in turn improves dietary diversity at household level. Intercropping helps in the event of those prolonged droughts caused by climatic variations. Farmers would be equipped to curb famine in their homes thereby averting succumbing to the shocks caused by climate change.

Farmer Field School was perceived would help in the realisation of more output. Also, farmers indicated preference over the resuscitation of the MFT programme that needed re-evaluation. Another option was to be trained through Field days. These are group methods that are participatory in nature thus facilitating easy adult learning. The level of crop production for the period 2015-2017 was generally good though some members indicated low yields due to drought, lack of labour, sickness, lack of inputs and the fall armyworm. On this note it was found that, FFS was the best training approach for better yields. For any approach to deliver results there is need for continuous review to be up to date with the current agricultural trends. Agricultural training should be afforded to both Extension officers and farmers to keep updated. Extension Officers need to be well resourced, economically and socially for efficient agricultural extension services. However, there is need for needs assessment and consultation of participants at programme planning through to implementation stage. The following, Chapter 5 discusses the results as presented.

CHAPTER 5: DISCUSSION OF FINDINGS

5.1 Smallholder Farming in Zimbabwe

The three irrigation schemes were male dominated exhibiting the patriarchal nature of societies in Zimbabwe. They were also dominated by the ageing population who were resettled under the old resettlement program, of the 1980s. There is reduced crop production as the old aged had less energy to take part in most productive activities (Musara *et al.*, 2019) and Urassa, 2015). However, these results deviate from findings by Baffoe-Asare *et al*. (2013) who reported that as farmer's age increases, their production of cocoa increases in Ghana.

High ownership of productive assets derived from crop production was observed among participating farmers. Livestock also added to the farmer's agricultural income for better livelihood. The social networking within the different communities of the different irrigation schemes was excellent. The social cohesion was catalytic to the more traditional farmers who grew in confidence on the information supplied by up-to-date farmers (Albizua, *et al.,* 2021). Proper land management or agrarian practices are enhanced through information sharing.

5.2 Training approaches offered to smallholder farmers in the schemes

Different training approaches received different reviews from the participants. The Farmer Field School (FFS) received rave reviews even though it was the least resourced form of training as it was participatory in nature and villagers would teach each other on new techniques. This approach is viewed as a school without walls that enables better decision-making in the farming communities (Khisa, 2021). In the Training of Trainers (ToT) approach, a selected group of people drawn from the irrigation management committee members were trained on the belief that these members would later impart their newly acquired knowledge and skills to the members of the different irrigation schemes. The level of grasping the different concepts taught depended on the level of intelligence of the recipient. The purpose for lead farmer extension approach was to do with cost cutting and wide coverage (Oyelami *et al.,* 2018). In support KSL (2023), highlights that the process involves training potential members of the community to train other farmers. The FFS give confidence to the poor farmers as suggested by Asiabaka (2015). These were the most used approach to train farmers in Zimbabwe. The Field Days approach organised feedback on new innovations through detailed discussions on demonstration sites (USAID, 2014). Despite these efforts to train farmers using the stated approaches, there is still a need for a more comprehensive and

targeted approach to training and extension services that considers the specific needs and challenges faced by smallholder farmers. Such approaches entail the use of farmer-to-farmer learning, the establishment of learning groups, and the development of tailored training programmes that address the specific needs and challenges of smallholder farmers. Thus, participatory methods of extension services are most favoured.

The results suggest high-capacity building among farmers to improve household food and income security. Training in aspects related to production and conservation of resources improves smallholder farmers' adaptation to different shocks that are key for economic development. Smallholder farmers were found to be lacking knowledge in pest management, post-harvest management and water management as critical skills among other aspects.

The study revealed low uptake of bookkeeping trainings as offered by ZFU and Ruzivo Trust. The low attendance is attributed to lack of needs assessment and level of education. Needs assessment presents a good opportunity to involve the community for successful developmental projects (Thompson, 2017). While there have been efforts to provide training programmes for smallholder farmers in Zimbabwe, these programmes have often been ineffective due to a lack of consideration of the specific needs and constraints of these farmers (Mugabe, 2015).

Information comprehension was different between the elderly and some youngsters due to different cognitive capacity. Participants indicated that some of the information was too technical for their uptake. The lectures were delivered with fewer practicals undertaken posing the risk of forgetting procedures when undertaking tasks individually. This explains the role of extension workers in improving farmers' access to information and advisory services. The uptake and diffusion rate of new innovations and technologies increase when the three levels of the mind are improved through proper information delivery (Mbure and Clare, 2017).

There were demonstration plots at all schemes, which were not utilised as prescribed by the parent ministry. Problems were noted at Chimhanda where farmers would collectively work on the plot and the produce was later distributed to selected individuals to sell leaving out the rest of the farmers. The whole essence of taking farming as a business was thus eroded. Farmers were in violation of good agricultural interventions (Makate *et al*., 2016) as group learning, and on-farm visits to improve maize yields were not followed. Zimbabwe Farmers' Union and Ruzivo Trust tried to change farmers' mind sets to take farming as a business by

shifting from subsistence farming to reduce poverty in households. Agribusiness is a vital element of most economies (Agossou, 2020).The new knowledge acquired need to be appreciated and applied to fulfil the domains of learning for productive farming.

5.2.1 Indicators of adequacy of agricultural training

Over 93 % of the farmers changed their agronomic practices and families realised a diversified diet, good food storage and preservation as production increased. The high rate of farmers who focused on pest management and post-harvest management training could be attributed to previous low yields that were caused by the outbreak of the notorious fall armyworm. The element of water management was also highly favoured by participants. It was because water had become scarce such that communities were learning ways of preserving the liquid. If the farmers who undertook the training managed to retain what was learnt, and be able to conserve water, ability to choose varieties that resist moisture stress is enhanced (Makoye, 2013).

5.2.2 Training offered to irrigated-maize farmers during the period, 2015-2017

Apart from ToT that was selective, bookkeeping had the least number of farmer attendants. Farmers tend to shun bookkeeping trainings as it requires many cognitive skills to be applied. Aged household heads resorted to sending grandchildren or any other family members to attend the training sessions on their behalf so that the knowledge could be applied on their plots. The exercise had moderate effects as it proved to be difficult to change mindsets, attitudes and opinions of the head (Mbure and Clare, 2017). Farming as a business, realises a small number of attendants as most of the farmers portrayed resistance to change as they remained relying on indigenous knowledge. The resistance led to successive crop failures during dry spells.

Aged farmers face deficits in cereal outputs every year due to a plethora of health problems. This scenario slows down participation in agricultural activities and training. Participants attending Farming as a Business, sessions were the middle-aged farmers who are enlightened on the current value of farming. Educated farmers are more likely to adopt early the introduced technologies. In contrast the lowly educated farmers are slow in partaking in agricultural activities including the adoption of new technologies. The rating of primary education (27 %) is a cause for concern as this can be a barrier in training because of low education.

Comprehension of the agricultural jargon might be difficult. The low attendance result is attributed to the level at which this training was offered. To enhance the effectiveness of training interventions, it is important to tailor them to the specific needs and challenges faced by smallholder farmers engaged in irrigated maize farming.

5.2.3 Participation and duration taken to complete training

The study results indicated that most farmers attended one-day trainings as reflected by the number of participants in pest management, post-harvest management and water management training.

Most participants preferred shorter periods of training as reflected in one-day training period slots as adults have competing roles. The number of participants in pest management and water management was high as adults want information and knowledge to address current problem. The outbreaks of the fall armyworm motivated participants to devote their time as the information impacted on their outputs and livelihoods. Conflicts were also established in the watering of the plots. It was found out that at Chimhanda Irrigation Scheme sprinklers were out of order and needed repair, but to get monetary contributions for repairs from the plot holders was proving to be difficult. As a result, members were poaching water at night and irrigating their plots at other people's time slots thereby disturbing the whole water distribution programme. Some plants eventually wilted as they could not be watered as and when necessary. The centre pivot and sprinklers methods used in the schemes were good for water conservation rather than ditch or flood water systems that results in loss of water.

Smallholder irrigation members need to be educated on water calibration so that operation is at recommended levels. There is a growing interest in integrating farmer training with technology adoption to enhance agricultural productivity. Extension workers need to guide farmers in ensuring correct application of the right pressure. A refresher course for the extension workers on calibration becomes mandatory for successful irrigation watering operations for the personnel to be able to offer adequate and good technical advice (Moreno-Pizani, 2021). It is known that irrigation systems managed by the public sector face budgetary restrictions, but efforts should be made. This approach is particularly relevant in the context of Zimbabwe, where a lack of access to technology has hindered smallholder farmers from realizing their full potential. By training farmers on how to use innovative technologies, such

as precision irrigation systems, and mobile apps for market information, they can improve their yields and reduce their reliance on traditional farming methods (Mapfumo *et al.,* 2019).

5.2.4 Farmer selection and organisation for agricultural training

Lead farmers were selected in the irrigation schemes. This was based on regular attendance. Training of Trainers was then offered for these famers to be representatives of their farming areas. The selection was influenced by the T&VS approach in agricultural training as supported by (*Feder et al., 2004*). The trained farmers then become teachers for other farmers. Voluntary farmer training approach has been adopted for more than ten years in Kenya (Lukuya *et al*., 2012). The method has the advantage of a wider coverage.

All plot holders were invited to attend scheduled trainings. The method was to afford every farmer a chance to participate so that no one was left behind to fill the gaps to avoid a divide in production levels. Plot holders who were not able to attend due to various reasons would send representatives. On the other hand, the farmers could possibly have ignored the training sessions as most learning is pedagogical. To ensure the success of training programmes, it is essential to address the challenges of resource constraints, lack of access to extension services, and cultural and socio-economic context.

Cultural differentiation should be observed as these can be a blockade to training as vulnerable groups are mostly left out. Farmer selection should have a criteria and punitive measures for those not utilising their land. Households with resources and keen to participate in scheme activities should be afforded the opportunity of owning a plot after repossession from non-participant farmers.

5.3 Assessing the perceived effectiveness of current training approaches on irrigated maize performance

Several criteria have been used to assess the effectiveness of training of smallholder farmers involved in irrigated maize farming. One of the major criteria is the level of knowledge gained

by the farmers because of the training. Training programmes that incorporate various learning domains result in greater knowledge acquisition among smallholder farmers.

5.3.1 Current training approaches in use for irrigated maize farmers

The success of agricultural extension services has been focussed mainly on farmers against behavioural change. The training programmes administered through the various approaches aimed at competency and capability building in the farmer for enhanced productivity and good farmer practices. It was noted from FGDs and extension officers in Chimhanda, Negomo and Eben Schemes that are currently in Zimbabwe, FFS were the most used approach to train farmers showing superiority over field days, innovation platforms and master farmer. This confirms the assertion by Asiabaka (2015) that these participatory approaches empower even the resource poor farmer. However, this approach was facing challenges of lack of funding for inputs from the parent ministry. The research found out that most farmers preferred working independently on their land as some plots would be chosen as demonstration fields. This was after the collapse of demonstration plots in all schemes. The non-compliance by farmers to work on demonstration activities led to the selling of the demonstration plot to a farmer at Chimhanda. The neglect of the use of demonstration plots could be a major contributor of low yields caused by poor farming practices and extension guidance. A study by Ndlovu *et al.* (2019) found that training programmes that focus on practical, hands-on activities and use demonstration plots for learning resulted in higher rates of adoption of recommended practices among smallholder farmers involved in irrigated maize farming.

The level of satisfaction and engagement of the smallholder farmers with the training program is important for its effectiveness. Field Days and FFS are participatory methods that were chosen by smallholder farmers in Mashonaland Central. This confirms Chipindu *et al.* (2018) assertion that training programmes that incorporate participatory learning methods and involve the active participation of farmers in the design and implementation of the training are more likely to result in high levels of satisfaction and engagement among smallholder farmers. Adults believe in learning by seeing.

Farmers in the irrigation schemes relied on the EOs' knowledge and advice to enhance their cognitive, affective and psychomotor domains. Farmers need to be well guided and trained for better production than to be continuously provided with financial and input assistance. Rather than waiting for Presidential Input scheme, irrigated maize farmers could form groups to buy inputs. The contributions become minimal and manageable than individualised

acquisition. It was reported that follow-ups by Extension Officers were rare unless called because of transportation problems. This fails what Bingen and Sanginga (2019) and Sharma *et al.* (2017) findings that training programmes that involve regular follow-up visits and reinforcement of learned concepts over an extended period result in sustained improvements in the knowledge, attitudes, and practices of smallholder farmers. Farmers have skills gaps that need to be filled in through training and development. The closure of gaps is realised if there is monitoring of participants applying theory into practice to for increased productivity.

As a way of trying to enforce training in the farmers, extension officers dedicated one day a week for training on various topics with the help of external facilitators. However, there was poor participation by the respondents at times. This could be attributed to the top-down approach as observed by Agbarevo (2013). However, the quality of the programmes was rated as average as training was hampered by lack of instructional materials. Agbarevo (2013) cites that the aim of extension at improving agriculture should assess how the resources and technology can help in overcoming production problems in the schemes. This caused the extension personnel to rely on lectures, which is a difficult method of teaching adults as preference is in practicals than theory because of the different cognitive capacities. Emphasis of training approaches should be based on skills development for self-reliance that may result in the improvement of better socio-economic status in the community thereby addressing the outmigration of youths to cities and towns. As extension is human centred, it aims at filling the knowledge gap and change of attitudes and practices for informed decision-making. As production increases, the energetic generation may be encouraged to take part in agriculture.

5.3.2 Farmer choice of approach

Implementation of agricultural extension approaches aims at giving satisfactory results through improvement of knowledge and skills in participants. An approach guides the planning process, organisation and management of extension services (Kaur and Kaur, 2018). Based on the findings Master Farmer Training (MFT) tended to be the most preferred approach although the government no longer offers it. Those participants who had the MFT certificate voted for its resuscitation as it had all the components required by farmers starting from theory to practicals to do with all farming aspects. Apart from good agronomic practices farmers were taught veterinary skills such as dehorning and vaccinating livestock on their own without waiting for veterinary specialists for assistance. Included was training on farm machinery

operations. However, one extension officer respondent highlighted that MFT needed revision as it had its weaknesses. Some of the extension officers interviewed, thought demonstrations, tours and field days were the best approaches to be used for adult learners in the schemes than MFT as it required mental capabilities. Some of the components of MFT were no longer applicable in today's agricultural practice. The old approach could however run continuously with the newly developed methods for the increase in agricultural potential as supported by Kaur and Kaur (2018). The Deputy Minister Lands, Agriculture, Water, Climate and Rural Resettlement, Douglas Karoro (The Herald, 26 March, 2021) reiterated the sentiments that the government need to resuscitate the Master Farmer Training programme for increased productivity and food security. The Minister emphasized the need for farmers to be trained to acquire requisite knowledge and skills to boost production and desist from being cellphone farmers. As such, farming communities were urged to make proper use of the land or risk losing their plots. The emphasis by Karoro and participants to re-introduce MFT for better agricultural production, however, contradicts Mika and Mudzimiri (2012) findings that MFT has no major impact on crop production nor does it bring change to individual farmers. The scholars concur with extension officers who were of the view that the principles and objectives of MFT needed to be reviewed. It was noted that the scheme does not have any impact on crop productivity neither does it change the farming system of individual farmers.

However, not all training approaches have been successful in enhancing smallholder farmer performance in irrigated maize farming. For example, a study by Hlongwane and Mushunje (2019) in Zimbabwe found that a training program that focused solely on the use of chemical fertilizers did not result in significant increases in maize yields. The scholars attributed this to a lack of consideration for other factors such as soil health and water management.

Overall, the perceived effectiveness of current training approaches on irrigated maize performance depends on various factors, such as the content of the training, the delivery methods, and the context of the farming communities. As such, there is a need to explore alternative training approaches that are tailored to the specific needs and circumstances of smallholder farmers involved in irrigated maize farming.

5.3.3 Crop Production Levels (2015-2017)

The ratio of agricultural outputs and inputs is agricultural productivity. Thus, the relationship between agricultural output and inputs is that they measure agricultural productivity (ZimStats,

2019). Although all the three independent variables (innovation platform, field days, farmer field schools) were not significant, they had some influence on the yield obtained by the irrigated maize farmers. An additional day for the various approaches contributed less output than master farmer training. Yield for MFT was 3800 kg/ha and was mostly attended compared to Innovation Platforms. This could be attributed to the imposition of new technologies by some NGOs into the scheme without making proper needs assessment.

There were, however, those 'the know it all' hence do not want to appreciate and learn from works done by others while others would not listen to the proceedings of the events thereby end up gaining nothing especially if it was a repeat lesson. One more training in the Farmer Field School would realise more output than master farmer training. Output at Negomo for those who attended FFS was 5000 kg/ha versus MFT at 3800 kg/ha. Smallholder farmers who received training through Field Days at Chimhanda had 3300 kg/ha compared to those who attended Innovation Platforms with a yield of 2800 kg/ha. The cause was that farmers learn by doing. Field Days realised less output than MFT. This might be attributed to the farmer missing some critical areas of concern as the farmer would try to balance training and social calling. The training might be happening in a different locality that might be a problem for women and physically challenged farmers to attend. Training programmes need to be well timed and to be afforded to the right people at the right time to avoid attention distraction.

5.3.4 The effect of training on maize production

Age of household head affects crop production in the three schemes. Most of the aged plot holders did not get the chance to be formally educated or access technical training for good agricultural practices. Opportunity International (2022) observes that if trained, household heads can increase yields through proper utilisation of inputs. Skills in farm management are enhanced. This can easily facilitate taking farming as a business and drift away from subsistence farming. With significant increase in yields, increased cash flow is realised for education, health and equipment acquisition. Farmers can easily pay the Command Agriculture inputs debts that leave most of them poorer than before. The success of the irrigation schemes in maize production leads to the improvement of the country's economy as businesses boom. Employment is thus created to serve the booming businesses. The factors that are affected by the age of the household emphasise the need to have active participants on plots than to have farmers who leave the land lying idle. Area of the cultivated land in the studied schemes was the same but production was different due to various factors.

Household size has a relative effect in maize production as members are a source of labour. The size of the household means high labour force for production that leads to improved production. Furthermore, large household size may also mean diversity of ideas regarding allocation of resources in production and adoption of technologies and innovations that improves maize production. This was supported by Urassa (2015) who found out that size of the household positively affect maize production. Similar results were found by Danso-Abbeam *et al.* (2018) who revealed household size to significantly affect maize productivity.

Training acquired also had a positive effect on maize production. Increased levels of training of farmers result in increased maize production. This suggests that as farmers are trained, they acquire more knowledge and skills to implement in maize production. Furthermore, trainings also improve farmer knowledge on different technologies and innovations that are important in improving their yield (Ogada & Nyangena, 2015). The results were also consistent with the findings of Danso-Abbeam *et al.* (2018) who found out that farmer participation in ACDEP agricultural extension training programmes results in improved agricultural productivity. Furthermore, Sebaggala & Matovu (2015) reveal that exposing farmers to extension programmes improve crop yield. Emphasising the need for training, a study by Waddington *et al.* (2018) in Malawi, highlights that training farmers on improved maize production technologies, such as seed selection and planting methods, was found to increase crop yields and improve food security.

The average income earned by households per annum had a negative effect on maize production. This meant that increased household income resulted in maize production decrease. This may be since households that had more income may have enough money to spend on food items reducing the need for production. Thus, families with high income do not concentrate on maize production as there are enough resources to supplement or buy grain after harvest.

a) Best training approach for better yield

The results from the regression model that was run, average yield of maize from 2015-17 Farmer Field Schools have shown a positive yield over Master Farmer scheme. Farmer Field Schools attained more yield than Master Farmer scheme. This implied that FFS approach was superior to MFT the reference approach and all other approaches in use. Farmer field schools' development has been promoted by institutions like the World Bank and FAO. The

approach was also employed in Kenya and Switzerland (Muller *et al.,* 2010) and it proved to effectively fill the gap in extension services. Farmers became more efficient and self-reliant and had the ability to manage scarce agricultural resources well. These results indicate that Farmer Field School tends to be the best current approach to use for increased output in the smallholder irrigated maize schemes in Mashonaland Central Province of Zimbabwe. This is supported by *Feder et al.* (2015), who posits that Farmer Field Schools (FFS) is an intensive training approach that was developed in many developing countries.

Negomo farmers were producing effectively, and maize was sold as green mealies as they fetch more money. It was worthwhile than to deliver to GMB. The results obtained, could however be misleading as some farmers had to guess the actual production for a particular year because of green mealies sales. Farmer participants prefer using group and individual methods in their plot activities. Group method is an adult learning process that allows sharing of experiences and ideas. Thus, emphasising the use of FFS as it is a participatory and group approach of extension services. The method applies all the three levels of the mind (cognitive, psychomotor and affective domains).

b) Farmer rating of crop production, 2015-2017

Rating of crop production was done for the three- year period. Agricultural production provides diversified and nutritional foods in households (Gondwe *et al.,* 2017). In the study households were affording 2 -3 meals per day. The indication was that farmers had no problems in the cognitive domain after training. It worked to the advantage of those who had better educational background. Others mostly benefited from demonstrations and field days more than lectures. The psychomotor and the affective domains were fulfilled as participants took part in the demonstrations undertaken. The lower ratings however, were associated with those who did not value the messages. Although some farmers had increased yields there were those who had no equipment or assets to use in the field. Thus, the economic environment affected production. It was noted a link exists between food production, income and diversity. The more income a household has at its disposal the more the food availability and diversified (Gondwe *et al.,* 2017). The country's GDP of the country is also boosted.

There was no significant difference in outputs after farmers engaged in the various trainings offered. However, each variable had its own influence on production. The results aided in determining skills shortages and where more training was needed to enhance maize production. Capacitating extension workers and farmers enhances agricultural training (Gondwe *et al.,* 2017). In essence properly trained farmers who are well supported in good agronomic practices make varied produce.

5.3.5 Assessment of current training approaches for irrigated maize farmers

In Zimbabwe the Master Farmer Training (MFT) was introduced during the colonial era. The scheme was not very popular in communities since it required high cognitive levels that was lacking in the smallholder farmers. Mika & Mudzimiri (2012) reveals that MFT had no positive impact on crop productivity. It was for this reason that it was recommended that policies and principles of MFT approach should be revised to meet current agricultural dimensions. Another traditional method was the T&VS system. The aim of the training method was for rural development. It was found that it was a top-down approach. This led to its failure. The finding is supported by Butt *et al.* (2015) in a study done in Pakistan. Farmer Field Schools (FFS) Feder *et al.* (*2004*), posits that Farmer Field Schools (FFS) is a rigorous training approach that was developed in many developing countries. The main aim was to increase the knowledge level of production and the minimisation of pesticides use. The approach was successful in Kenya and Switzerland (Muller *et al.*, 2010) and in Pakistan (Butt *et al.,* 2015). Zimbabwe through ARDAS, it was found that FFS has been introduced and the method is currently running in most of the irrigation schemes, and it was noted that using this approach increased yields.

The approaches used in the colonial period included group development area approach (GDA), radio listening approach, training and visit system (T&VS) and farming systems research and extension (Hanyani-Mlambo, 2013). After independence in 1980 farmer training was strengthened to include radio programmes like `*Murimi Wanhasi'* /Today's Farmer that is aired at scheduled times at least twice a week by a local seed company. The programme has now been changed to Talking Farming that covers information using the three major languages. Another approach used was the Eco-Farmer that had recently been introduced by a local cellular company. Information is sent to farmers through mobile phones just like in Tanzania (Makoye, 2013).Farmers received real-time whether information through mobile phones. Mass media has the advantage of covering a wide geographical area. Use of mobile

extension services and the use of information and communication technologies have also been introduced (Mhlanga *et al.,* 2020). These interventions have been shown to improve farmers' knowledge and skills in a range of areas, including soil fertility management, water management, and pest and disease control (Kamwi, 2019). Agricultural Extension Methods considered aimed at improving agriculture productivity but should first understand the current farming systems. Technology and resources should also be considered if low farmer production is to be overcome. It was therefore, found necessary to examine the adequacy of current training approaches in the irrigated maize farming in Mashonaland Central. The approaches used helped in the establishment of the level of knowledge, change in attitude and application of skills by the farmers studied.

In summary, traditional training approaches for smallholder farmers in irrigated maize farming have been ineffective in addressing farmers' specific learning needs, resulting in low adoption and application of new farming practices. The learning domain-based training approach has shown promise in addressing this gap and has been effective in enhancing farmers' capacity and performance. However, the perceived effectiveness of current training approaches on irrigated maize performance by smallholder farmers remains low, indicating the need for more innovative and context-specific training approaches that consider farmers' specific experiences, attitudes, and beliefs.

5.3.6 Most preferred delivery methods

Participants indicated the most preferred instructional methods in the irrigated maize farming in Negomo, Eben and Chimhanda Irrigation Schemes as the demonstration method. It emphasises the use of demonstration plots using the FFS approach. Farmer participants are a mixed bag with literate, semi literate and illiterate members. Some members opted for lectures as a second delivery mode. The method allows wide coverage of aspects as observed by the institution of MFT, hence the need to resuscitate it as advocated by Karoro (2022). Using a training program that focuses on cognitive, psychomotor and affective domains leads to an increase in farmers' knowledge and skills. The program integrates classroom instruction with field demonstrations. Agricultural training encompasses formal and non-formal education.

5.4 Adoption of innovations and skills of farmers in irrigated maize farming

The participation in pest management, timely harvesting and post-harvest management was an indication of how adults learn. Farmers were only concerned with problems that could affect their harvest rather than concentrating on bookkeeping although it is considered important for successful farming. Training programmes that focused on technical aspects, such as pest control, were more effective in enhancing farmers' productivity compared to those that focused on social aspects. The provision of education and training programmes is essential in equipping smallholder farmers with the necessary knowledge and skills to improve their productivity and income. Farmers considered the information to be valuable and even appraised the way trainings were conducted. However, participants highlighted failure to recall the taught information when trying to apply theory into practice. On this analysis, Extension Officers admitted that there were certain terms used that were difficult to translate into vernacular making it difficult for adult learners to comprehend. The language and communication methods used in the training should be appropriate and effective for the targeted audience. This includes the use of the local language and the use of visual aids and other instructional materials to aid learning. This aspect reiterates the importance of demonstration plots. It is difficult for adult learners to rely on theory without practice. This also confirms Knowles (1980) assertion that adults learn better in groups. The effectiveness of a training session is normally based on how the delivery influences the participants. Mashingaidze *et al.* (2016), concurs that, training interventions need to be delivered in a language and format that is accessible to the target audience, which in Zimbabwe may include people who are not literate in English. Extension worker should, therefore, be well equipped and skilled to be able to deliver the information to participants. In Zimbabwe it was proved that the relevant Ministry was resource poor as it failed to equip agricultural personnel for effective agricultural extension delivery.

To achieve viability of farming enterprises, there is a need to provide appropriate training programmes that address the specific needs of smallholder farmers. Such training programmes should be designed to improve the cognitive, physical, and socio-emotional skills of smallholder farmers and should be accessible to all farmers, including women and older farmers. Additionally, the training programmes should be designed to be interactive and participatory to ensure that the farmers are actively involved in the learning process. The adoption of new practices by farmers in Chimhanda confirmed the applicability of the affective domain that makes people change behaviour.

The assessment of the level of farmer skills and knowledge helped to establish the impact of training on livelihoods. The positives of the trainings were that families managed to have diversified food on their tables. Eradication of hunger and poverty as argued by SDG-1 was therefore fulfilled. Reasons for poor or low output were due to limited knowledge and applications to appropriate agronomic practices for different crops (Nkabule & Dhlamini, 2013; Makate, 2019). Fanadzo *et al.* (2010) concurred to Nkabule & Dhlamini (2013) observation on poor performance by farmers. These conclusions by the scholars were addressed in the studied schemes as farming as a business and record-keeping were introduced as part of the training sessions.

The efforts by ARDAS and other stakeholders was to try and fill the gap in the level of skills of farmers involved in irrigated maize farming. Skills are an essential factor that determines their capacity and performance. Smallholder farmers often lack access to education and training opportunities, leading to limited skills and knowledge on sustainable farming practices. As a result, the application of appropriate irrigation technologies, use of quality inputs, and adoption of modern farming techniques is hindered, leading to low productivity and income. Agricultural extension is an important catalyst in the development of irrigation schemes. These services are needed for irrigation scheme sustainability to enhance the effective development and management of irrigation schemes for increased production.

5.4.1 Expected farmer skills in irrigated maize farming

The level of skills of farmers involved in irrigated maize farming is an essential factor that determines their capacity and performance. Skills can be categorized as cognitive, physical, and socio-emotional. Cognitive skills are related to the understanding of technical concepts related to maize production, while physical skills relate to the ability to perform physical tasks related to maize farming. Socio-emotional skills are related to the ability of farmers to interact with other farmers and the wider community.

Farmers did not have soil fertility management skills and knowledge in conservation tillage. Maize farming is known to cause soil degradation due to the intensive application of inputs (Brown, 2011). This is an indication that smallholder farmers in Zimbabwe lack the technical skills necessary for successful irrigation farming. These farmers have limited knowledge of crop management, soil fertility, and water management that can affect the yield and quality of their maize. Farmers need to have post-harvest skills to avoid food losses after harvesting.

This was evidenced by the number of participants who turned out for the training session. This finding was supported by Adejo (2019). Above all, farmers need to stay up-date with current information on maize production. Marketing techniques (procurement and selling skills), newly introduced production machinery and technologies are skills required for effective outputs (Langemeier & Boehlje, 2018). The study indicated that smallholder farmers had no market linkages resulting in localised marketing and selling. Interpersonal relationships must be strengthened so that farmers are not left behind thus, reflecting the importance of social networking where people share experiences and knowledge.

It is important for farmers to be flexible and adaptive when faced with unexpected challenges. Farmers were faced with armyworm challenges resulting in the need for skills and further trainings. Murwira (2016) noted that the skills and knowledge of farmers in Zimbabwe on sustainable farming practices have been found to be inadequate, leading to low crop productivity.

a) Irrigation water management skills

Farmers in the three schemes lacked proper water management skills. The finding was supported by various studies carried out on SIS that recommended farmer training in water scheduling. In a study by Bhalage *et al.* (2015) reiterates that lack of control structures for irrigation water supply to intended plots causes over irrigating problems. It is on this argue that farmers need to know the actual water applications to plants to avoid unnecessary losses through continuous flow of water. On the other hand, incorrect application of water might cause reduction on the farmer's production levels. It is advisable for farmers to have general knowledge of technologies related to agriculture. Farmers lacked enough water management skills especially at Chimhanda as evidenced by the study. This finding is also supported by a study by Mupangwa *et al.* (2012) that reported that smallholder farmers in Zimbabwe lack knowledge on efficient use of water resources, leading to inefficient irrigation practices.

Mechanical ability is one of the key skills required by farmers. One needs the psychomotor skills in the operations of the irrigation as machinery constantly requires checks and maintenance. This is a basic skill that a farmer needs to possess to avoid stopping work because of a dysfunctional sprinkler valve. In the study sprinklers were lying idle as the farmers and Extension Officers were not able to connect the equipment. It was noted in a previous study that farmers had limited skills and knowledge on the application of appropriate irrigation technologies and modern farming techniques leading to low productivity and income.

The general observation was that most farmers were not taught on how to calibrate to have normal water levels. This meant most of the farmers involved in irrigated-maize farming in Zimbabwe faced the same challenges of poor irrigating methods. The parent ministry was therefore, falling short on this aspect. There were issues that could be easily addressed like mounting of equipment. The Ministry of Agriculture is incapacitated to provide manpower for that, and farmers had to be taught to do it on their own. This way self-reliance and self-confidence are fulfilled. Poor water management emanates from most EOs who also lacked the skills. Providers of education such as the vocational, colleges and universities should include these aspects in their curriculum.

Mostly, farmers, base their decisions on subjective judgements using their old practical experiences and sometimes observation that do not match today's agricultural technologies. This ignorance makes them realise less benefits from irrigation innovations and technologies. It was highlighted that farmers lacked the skills to develop and adopt appropriate and relevant approaches to irrigation farming. Brown (2011) states that, the knowledge is provided by extension services through helping farmers to adapt viable solutions and technologies and implementing them. The use of sprinklers as a choice for irrigating crops in the three schemes ensures preservation of the special and scarce resource. Climate change on the other hand poses as a challenge to the already dire situation resulting in the reduction of water resources.

b) Agricultural information availability

Farmers need a variety of information that includes marketing, new hybrid seeds, planting, post-harvest methods, pest control and prevention of other plant diseases and real weather conditions as per (Bernard *et al*., 2014) recommendation. Provision of relevant information enables farmers to make informed decisions as they become knowledgeable. Farmers no longer rely on knowledge passed on from parents, household members, neighbours and personal experience in agronomic practices due to the trainings attended. Agricultural information centres were put up in all areas so that information was easily accessible. This always included accessibility and availability of EOs when the farmers faced challenges. It is in this vein that Bernard *et al.* (2014) posits that for this information to be useful, it must be timely, accurate, relevant, cost effective and usable.

5.4.2 Adoption levels of skills and knowledge of agricultural innovations and technologies

It had been noted over the years that the demand for maize in Zimbabwe outpaces the supply. In the 2015 and 2019 cropping seasons the Government of Zimbabwe introduced measures for importing maize grain so that the country could not go hungry. This was an indication that the trainings that were offered to farmers in irrigation schemes were not very effective as food scarcity persisted with specific reference to Mashonaland Central Province. Smallholder farmers realised their shortcomings and all members participated in the offered trainings. Pest management had the highest frequency of farmer attendance in all schemes. The country had been hit by the problem of armyworm and fall armyworm that prevailed that farmers required skills and knowledge to manage. Pest management is followed by post-harvest management. Communities were faced with the problem of large stalk borer that was even attacking the maize in the field before storage. In support of the undertaken trainings, Mugwira *et al.* (2020) posits that the use of learning domain-based training approaches is beneficial in improving the level of skills among smallholder farmers involved in irrigated maize farming. By incorporating the principles of adult learning, such training approaches can be designed to be learner-centred, interactive, and participatory that can increase the effectiveness of the training programmes (Mugwira *et al*., 2020). Farmers who have high levels of skills in irrigation farming had higher yields and better-quality maize than those with low levels of skills. The low level of skills among smallholder farmers in Zimbabwe is attributed to a lack of formal education, training, and extension services. Most smallholder farmers have only basic education and have limited access to training and extension services. In this case, farmers were shunning those trainings they deemed difficult. This limits their ability to adopt new technologies and innovative farming practices.

The non-adoption by farmers should be a cause of concern. The country would continue to have perennial cereal shortages and fail to fulfil SDG-1 as advocated. There should be monitoring and evaluation of all schemes to assess the level of adoption. A policy should, therefore, be developed to cater for non-adopters. Laggard should not be left misusing the land instead of being productive. If farmers are trained and had changed mind set as to grow small grains than the staple maize crop, then food shortages could be averted in areas like Chimhanda. Farmers' knowledge on the hybrid seeds suitable for their regions as discussed in literature review for enhanced production is vital.

In Chimhanda a large percentage of participants applied skills on viability assessment and cattle manure. Farmers had been enlightened on the benefits of record keeping tobe successful farmers. Financial management skills for developing effective accounting system

are key to successful farming (Langmeier & Boehlje, 2018). Self-reliance and confidence were enhanced, and the donor syndrome eroded. Farmers in Eben and Negomo were mostly concentrating on viability assessment. Farmers need to have updated information and know factors affecting the agricultural environment (Indeed.com, March 2021). Skills imparted lead to increased production and storage of the cereal crop after harvesting.

5.4.3 Attributes, skills and roles of Agricultural Extension Officers

Agricultural Extension Officers have the mandate of disseminating useful information to the people they work with, encouraging them to adopt the new ideas. They have the responsibility to offer extension services to farmers through ARDAS in Zimbabwe. The success of an extension worker is determined by the effectiveness and efficiency of communicating the required information at the right time to the right people in the right manner that is understandable. Contrary to this need for proper communication in agricultural services, Mutambara *et al.* (2014); Kangara *et al. (*2021) argues that some Extension Officers lacked the required qualifications and experience corresponding with production levels in the schemes. Often institutions ignore human capital development that deals with personal knowledge, attitudes and behaviour favouring the improvement of institutions and infrastructure. Training of extension officers takes three years at agricultural colleges, vocational colleges and universities (Kangara *et al.,* 2021) instead of six months diplomas.

Sani *et al.* (2015),argues that the success of any extension work is dependent on the power of motivation and the capability to organise people when conducting mass activities. However, EOs should be able to control and manage the activities of the extension office, of course respecting the anthropological and sociological structures such as the chieftainship and political leadership. The success or failure of developmental projects depends on the qualities and capabilities of the assigned extension officer.

It was noted that EOs were poorly resourced in terms of computer literacy which was necessary for researching. They are expected to provide prompt and relevant solutions to presented problems such as the outbreaks of pests despite challenges faced. The situation de-motivated EO's although the personnel were readily available and accessible when clients needed services as noted by (Lukuya *et al.*, 2012) in his study in Tanzania. Extension personnel also showed tolerance to all situations as IMC membership controlled the running of the schemes. However, the farmer-extension officer ratio remained an issue because the

SIS were different in sizes and the number of plot holders. In this case, Negomo had 296, Eben, 42 and Chimhanda 134 but each being served by one extension officer despite the numbers involved.

It was found that EO's needed refresher courses to enhance their skills. Averbeke & Mohamed (2012) in their study recommends that the South African government consider having an agricultural policy for the development of training of extension officers assigned to support the smallholder irrigation schemes (SIS) farmers. One of the major issues highlighted was communication in terms of report writing and good delivery skills. The issue of good communication was supported by Chauhan (2007) when it was noted that the success of an extension worker was based on the effectiveness and efficiency of communicating understandably and in the right manner to gain respect from the audience.

5.4.4 Farmer-extension-researcher linkages

The close coordination developed with research organisations, enabled the scientific data to be relayed to farmers for a lasting solution found through research. In Mashonaland Central Province, organisations such as the Zimbabwe Farmers' Union, Lead, Ruzivo Trust, Agricultural Marketing Authority and Community Technology Development Trust serviced the areas in a bid to improve livelihoods through farmer education. The knowledge acquisition is a continuous and long-life process that has important effects on agricultural production as revealed by various studies. Farmer-researcher linkages are the linking pins of farmers and innovative practices for better income benefits. Extension Officers are therefore expected to facilitate the linkage between research and farmers (Battilani, 2012).

5.5 Ways of Improving the Current Training Framework

5.5.1 Introduction

Smallholder farmers in Zimbabwe face many challenges in adopting new agricultural technologies and practices that may limit their productivity and income. To address these challenges, there is a need for improved training programmes that provide farmers with the knowledge and skills they need to succeed. A learning domain-based training approach is one potential solution that can help to address this need.

The aim of the study was to come up with a new training framework or to improve the existing training framework in the irrigated maize farming in Mashonaland Central Province of Zimbabwe. Farmers and extension personnel indicated that FFS was the best approach and was currently used in the training of farmers. Smallholder farmer in Zimbabwe face many challenges in adopting new agricultural technologies and practices, which may limit their productivity and income. To address these challenges, a learning domain-based approach is one potential solution that can help to address this need.

5.5.2 Components and characteristics of an improved domain-based learning framework

Learning domains involves organising the training content into three main domains: cognitive, psychomotor, and affective.

a) Components of an improved domain-based learning framework

1. Needs assessment

Specific training needs of smallholder farmers in irrigated maize farming are identified. The component aims at identifying the knowledge gaps and skill deficiencies of farmers that need to be addressed through training.

2. Training Methodologies

Appropriate training methodologies that are aligned with the learning domains are selected. For example, lectures, discussions and demonstrations are suitable for the cognitive domain, while hands-on practice and simulations are appropriate for the psychomotor domain. As such the training methodologies should be guided by principles of adult learning. There were more lectures than demonstrations and practicals took long to be exercised due to lack of resources. Demonstration plots were no longer functioning at all schemes and farmers requested for their resuscitation so that the learning is done at a central place than on an individual farmer field.

3. Training Materials

Visual aids, handouts, and videos are suitable for the cognitive domain, while tools, equipment and materials are appropriate for the psychomotor domain. These materials should be

designed to be interactive, practical, and easy to understand. Programme planners should however consider the visually and hearing impaired when designing the instructional materials. It was noted in the study that instructional materials were mostly not developed as the Ministry could not afford to avail such things as flip charts and markers resulting in reliance on lectures.

4. Monitoring and Evaluation

The improved domain-based training framework involves continuously monitoring and evaluating the effectiveness of the training programme. This is done through feedback from the farmers and assessment of their performance. The results are used to adjust the training programme to improve its effectiveness. Monitoring and evaluation of training programmes facilitates sustainability of implemented approaches. This aspect was found to be lacking in the irrigated maize schemes. Farmers indicated that there was no monitoring of the practicals undertaken on individual fields after lectures and demonstrations. Monitoring was only done upon request of which those farmers who wanted to stick to old farming practices were not keen to be monitored so they simply did not call the EO. Extension Officers cited challenges of transportation to visit the schemes. One day a week was scheduled for the scheme meetings.

5. Financing

The improved domain-based training framework should be well resourced to effectively produce increased maize yields. Farmer field schools need to be well resourced to provide its clientele with the necessary knowledge, skills and enabling change of attitudes. Farmers requested for easy access to credit facilities. It has been noted by various authors that effectiveness of agricultural interventions is often limited by inadequate funding and lack of resources among other issues. Credit facilities should be availed to the smallholder farmers for input buying. Participants could be encouraged to do group buying of inputs or those who can afford to buy as individuals. Financial injection in the operations of the irrigation schemes especially the training area need re-evaluation. This was the mandate of the department of ARDAS under the Ministry of Lands Agriculture Fisheries Water and Rural Development.

6. Communication for Innovation

The framework will also involve the use of extension services. Extension services will provide farmers with information and guidance on the latest technologies and practices in irrigated

maize farming. This calls for the capacitation and motivation of extension officers for proper implementation and delivery of the teaching and learning process. The framework will incorporate use of mobile technology. Mobile technology enables farmers to access information on-demand and communicate with extension officers and other farmers. The technology will enable farmers to access real-time weather information that is critical for planning and decision-making in irrigated maize farming. The framework will also make use of aired radio and TV programmes on farming activities. Mass media has the advantage of a wider coverage.

7. Farmer-Research-Extension Linkages:

An improved learning domain-based framework for training farmers in irrigated maize farming could be developed through collaboration with farmers and other stakeholders. The research established that there should be strong farmer-researcher-extension linkages such as the associations with Lead Trust and Ruzivo Trust in Mashonaland Central irrigated maize schemes.

b) Characteristics of an improved domain-based learning training approach

1. Participatory Approach

The framework emphasizes the active participation of smallholder farmers in the training process. Farmers are encouraged to contribute to the selection of training topics and methodologies.

2. Context-Specific

The framework is designed to be context-specific, taking into consideration the unique needs and challenges of smallholder farmers in irrigated maize farming.

3. Practical Orientation

The framework emphasizes practical training that involves hands-on practice and simulations to ensure that smallholder farmers acquire the necessary skills and competencies.

4. Flexibility

The framework is flexible and can be adapted to suit the specific needs and circumstances of smallholder farmers.

5. Sustainability

The framework is designed to promote the sustainability of the training program by ensuring that farmers can apply the knowledge and skills they have acquired in their farming activities.

In conclusion, the improved learning domain-based framework for training farmers in irrigated maize farming is a comprehensive approach that is designed to address the knowledge gaps and skill deficiencies of smallholder farmers in Zimbabwe. The framework is characterised by its participatory approach, context-specificity, practical orientation, flexibility, and sustainability. The components and characteristics of the framework are aimed at enhancing the effectiveness of training and improving the performance of smallholder farmers in irrigated maize farming.

5.5.3 Summary

The main objective of the study was to determine if and how the domains of learning were applied in the training of farmers involved in irrigated maize production in Mashonaland Central Province of Zimbabwe. This was done to assess the causes of smallholder irrigation farmers' failure to produce maize effectively. The main objective was addressed through addressing specific objectives as listed.

The first study objective identified the key learning domains for effective use of irrigation technologies in smallholder maize farming in Mashonaland Central Province. Farmers' age showed skewed outcomes. Results show that household headship in the three irrigation schemes was male dominated with (84 %, 88 % and 64 %) in Chimhanda, Eben and Negomo Irrigation Schemes respectively. A significant relationship in sex and irrigated maize farmers was noted. Farmers were trained as mixed groups with no gender and age segregation. This affirms the assumption that age and gender are not important factors in farmer selection for training sessions. Farmers received training through the Master Farmer Training (MFT), Trainee Master Farmer, Training of Trainers (ToT) and Farmer Field Schools (FFS). Results reveal that FFS was the commonly used approach in Zimbabwe particularly, in the studied schemes.

The prime goal for ARDAS is to offer extension services to farmers. It was however found out that other players also helped in the training of farmers. Non-governmental organisations, Ruzivo and Lead Trust are some of the institutions that helped ARDAS in the training of plot holders. Of the various trainings offered, farmers shunned bookkeeping sessions as it demanded high cognitive levels despite its importance. Majority of farmers were old and had primary level education. Water management although it is a vital component in irrigation schemes, it was not introduced as the EOs also required training on water calibration. Results

also revealed that participants who attended the training sessions managed to get increased yields and income during the period 2015-2017. A total of 79 % of smallholder farmers indicated that information was not easily comprehensible because of the technical jargon used. This affirms that level of education has a positive impact on the level of adoption of technologies. It was established that household characteristics affect decision-making. Households headed by widows their probability of adoption decreases due to lack of collective decision-making and lack of encouragement from their spouses.

The second study objective was to develop a training approach that is tailored to the identified learning domains and the specific needs and constraints of smallholder farmers in Mashonaland Central. As a way of improving the current agricultural framework in use, refinement of existing models through research might bring out some insights on how to improve the frameworks is required. The study revealed that participants were favouring participatory methods where farmers are involved from planning to implementation stage. The choice of FFS is indicative of this preference. Authorities should therefore move from the top-down approach to participatory methods. Demonstrations were ranked first by most of the farmers indicating that participants choose to see actual processes as they happen. Use of ICT platforms, financial assistance and human capital development should be considered in the improvement of the FFS as a chosen approach to be developed considering the components and characteristics of developing a domain-based learning approach.

This framework would be designed to address the specific needs and challenges of smallholder farmers in Zimbabwe and would be tailored to their individual learning needs. The framework would be based on the principles of adult learning and would include a range of activities such as group discussions, field demonstrations, and practical exercises.

The third objective was to evaluate the impact of the proposed training approach on the productivity and income of smallholder maize farmers in Mashonaland Central Province. This was done through examination of the training approaches currently used and the extent to which each approach affects yields. The best perceived training approach by farmers was also assessed. The training approaches employed in Zimbabwe included the Master Farmer Training (MFT), Group Development approach, Training and Visit System, Field days, Farmer Field Schools (FFS), Mass media and Innovation Platforms. Farmer field schools as a training approach was considered best by both EOs and farmers engaged in irrigated maize in Mashonaland Central Province. It was also the best perceived approach that yielded results

during the period 2015-2017. Participants who failed to get good harvests during the period cited lack of inputs and labour as causes for the food insufficiency especially in Rushinga District. Household head characteristics like education and size had effects on crop production. Increased cereal productivity depends on the adoption of technological changes and attitude of the farmer. Training had a positive impact on both income and maize yield. Farmers preferred Master Farmer Training resuscitation as it embraced all aspects of agricultural practice, thus addressing the domains of learning. It was however felt the approach warranted re-evaluation to include the modern-day farming methods. It must be noted that no one approach can be said to suit all farming situations as there are advantages and disadvantages associated with each method as a single entity. The assumption that ideal training approaches enables farmers to achieve better yields in irrigated maize is affirmed.

The fourth objective assessed the effectiveness of the proposed training approach in improving the knowledge and skills of smallholder farmers in the use of irrigation technologies for maize farming. This was done through examination of the skills possessed by farmers involved in irrigated maize farming. All plot holders were invited to attend trainings as they were offered. Pest management and post-harvest management trainings were highly attended.

It was found out that the parent Ministry lacked resources to facilitate effective agricultural extension that lures farmers to adopt the new technologies and innovations. There was also need for the parent Ministry to fully resource the department of ARDAS for this cause both in the field of practice and its personnel socially and economically.

5.6 Implications

Learning Domain Theory (LDT) is a theoretical framework that seeks to explain the process of human learning through the identification and description of learning domains. The theory has been widely used in the development of instructional materials and training programmes in various domains. It provides a systematic approach to designing effective instruction by identifying the appropriate type of learning domain, selecting appropriate instructional methods, and evaluating learning outcomes. For example, the cognitive domain may focus on issues like identifying and treating crop diseases. Using LDT to design agricultural training programmes can help improve smallholder farmers' capacity and performance and promote

sustainable agriculture in developing countries, Mashonaland Central Province of Zimbabwe included.

5.7 Practical Implications

The application of DT in agriculture and farming has been limited but has the potential to improve smallholder farmers' knowledge and skills. By identifying the learning domains necessary for successful farming, LDT can help design targeted training programmes that meet farmers' specific needs. For example, a training program for irrigated maize farming may focus on the motor skills domain, such as proper land preparation and seed planting. Theory is a set of related tasks and skills that have a common structure and can be taught through similar instructional methods. These activities aid in the adoption levels for increased productivity in irrigated maize farming.

5.8 Limitations of the study

During the study several limitations were encountered that had an impact on the overall output of the research. The limitations included difficulties in securing appointments with Key Informants and authorisation to carry out research in the area. Some of the Districts were politically volatile resulting in the researcher going through the traditional leadership to be introduced to the community at the community entry stage. The political element required the researcher to be astute in questioning the respondents.

It was difficult to extract entirely honest answers in some instances as respondents tried to please the researcher expecting some form of rewards after interviews. This is attributable to some organisations that are in the habit of dishing out goodies after interaction with villagers. The researcher had no incentives due to financial constraints. Another cause for false responses was due to interview fatigue resulting from the area being over researched on other topics. Respondents were experienced in being interviewed and knew the type of answers required. This was experienced in one of the irrigation schemes where the researcher ended up going through extension officers to extract some information from the participants as they showed no interest at all. A few respondents failed to interpret the questions resulting in outlier answers.

Transport difficulties were experienced by the researcher when moving from agricultural offices to irrigation schemes. In one scheme the researcher had to walk a total of 28 km to

and from the scheme. Accommodation was also a challenge as some of the research areas were in the most remote rural part of the country where it was difficult to get housed. The researcher was fortunate in one of the schemes to be housed by the IMC Chairperson.

CHAPTER 6: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This research aims to investigate the effectiveness of a learning domain-based training approach in improving the knowledge and skills of smallholder farmers in Mashonaland Central Province of Zimbabwe on irrigated maize farming. Specifically, the research assessed the impact of the training approach on the participants' knowledge and skills, as well as their adoption of improved farming practices.

Maize is a staple crop in the country and is an important source of food and income for smallholder farmers whose production has remained low due to a range of challenges. There is a need for innovative approaches to training and extension services. Despite this realisation, most countries have not considered how people receive and share knowledge. The LDT was instituted to assess the level of skills possessed by people participating in irrigation schemes. The learning domains try to limit the non-participative and mere knowledge transfer by educators and trainers.

The study was guided by the following objectives: identifying the key learning domains for effective use of irrigation technologies in smallholder maize farming in Mashonaland Central Province; developing a training approach that is tailored to the identified learning domains and the specific needs and constraints of smallholder farmers in Mashonaland Central Province; evaluating the impact of the developed training approach on the productivity and income of smallholder maize farmers in Mashonaland Central Province; assessing the effectiveness of the developed training approach in improving the knowledge and skills of smallholder farmers in the use of irrigation technologies for maize farming. The findings of this study provide insights into the consideration of the learning domains when training smallholder farmers.

A synthesis of the whole study is provided in this study. The methodology used and major findings in relation to the study objectives are presented. The chapter concludes by suggesting relevant recommendations for inclusion of the learning domains in maize irrigated maize farming training.

6.2 Synthesis of the Study

Objective 1: To identify the key learning domains for effective use of irrigation technologies in smallholder maize farming in Mashonaland Central Province

In Mashonaland Central Province, the key learning domains for the effective use of irrigation technologies in smallholder maize farming are critical to improving agricultural productivity. The study adopted a mixed-method approach, employing a Knowledge, Attitudes, and Practices (KAP) survey design to gather comprehensive data. Stratified sampling was used, with each district serving as a stratum, and random sampling was conducted for all farmer households. Additionally, purposive sampling targeted District Administrators and Extension Officers as key informants. Data collection methods included questionnaires, focus group discussions (FGDs), participant observation, preference ranking, formal and informal discussions, and the analysis of both secondary and primary data. The data was analyzed using descriptive and inferential statistics, including the Chi-square test for independence and ordinal logistic regression, with SPSS version 20 as the statistical tool.

Smallholder farmers in the region displayed a mix of training backgrounds, with some having participated in approaches such as Master Farmer Training (MFT), Farmer Field Schools (FFS), and Training and Visit System (T&VS). A few had even attended Training of Trainers (ToT) programs. The introduction of cognitive, affective, and psychomotor domains in training significantly impacted farmer productivity. Those who received training exhibited improved skills and knowledge, leading to increased yields and better decision-making. However, a skills gap persisted, as some farmers lacked comprehensive knowledge of good agricultural practices, attributed to limited training opportunities, low levels of education, and the advanced age of certain farmers. Cognitive levels and age were crucial factors influencing the adoption of new technologies.

The most preferred training topics among farmers were pest management, post-harvest management, and farming as a business. Extension officers often resorted to using vernacular languages during training sessions to enhance comprehension. Despite this, technical jargon sometimes proved challenging to translate, leading to gaps in understanding. The language and teaching aids used were often inappropriate for

adult learning, and vulnerable groups such as the visually and hearing impaired were frequently overlooked. Furthermore, interaction between extension officers and farmers was minimal, influenced by various socio-economic and emotional factors.

For training programs to be effective, it is essential to involve farmers from the planning to the implementation stages, ensuring their needs are assessed to prevent ill-timed and poorly received programs. Trainers must consider the socio-cultural aspects of the area to make the training sessions relevant and engaging. Building high capacity among smallholder farmers is vital for improving their adaptation to various shocks. However, challenges such as manpower shortages due to rural-urban migration of youth and the reduced productivity of the elderly remain significant issues. Programs imposed without farmer involvement often face low adoption rates and poor outputs, leading to de-motivated trainers and suboptimal decision-making among farmers due to a lack of understanding. Addressing these issues is crucial for enhancing the overall productivity and sustainability of smallholder maize farming in Mashonaland Central Province.

Objective 2: To develop a training approach that is tailored to the identified learning domains and the specific needs and constraints of smallholder farmers in Mashonaland Central Province

Developing a training approach tailored to the identified learning domains and the specific needs and constraints of smallholder farmers in Mashonaland Central Province is essential for enhancing agricultural productivity. This training approach should incorporate feedback from the community through open invitation workshops and use questionnaires to gather comprehensive data. Reviewing historical profiles as secondary data can provide context, while breakaway groups for brainstorming and farmer participation in contribution analysis and preference ranking will ensure the approach is participatory. The data should be analyzed through preference ranking by participants to capture their priorities and needs, and narrative analysis can provide deeper insights into their experiences and expectations.

To improve the current framework, implementers should consider several key aspects. The improved learning domain-based framework for training smallholder farmers in irrigated maize farming should be comprehensive, addressing knowledge gaps and skill deficiencies specific to the region. This participatory, context-specific, practically oriented, flexible, and sustainable framework will be more effective. The chosen Farmer Field School (FFS) approach aims to enhance training effectiveness and improve the long-term performance of smallholder farmers in irrigated maize farming.

Other stakeholders should consider promoting remotely placed irrigation schemes based on the components and characteristics of the developed framework. Efforts to improve access to extension services should include the use of mobile extension services, enhancing the reach and effectiveness of the FFS approach. While no single approach can fully address the agricultural improvement needs, a mix of traditional and new extension methods will yield better results, taking into account the cognitive, affective, and psychomotor levels of farmers.

Traditional methods are increasingly out of sync with current agricultural trends, making it imperative to integrate modern techniques and knowledge. If FFS are not promoted, basic needs may remain unmet, as low production levels in irrigation schemes persist. The lack of needs analysis and a top-down approach often leads to the collapse of developmental projects. Furthermore, a sense of neglect among farmers in remote irrigation schemes can negatively impact production levels. Therefore, involving farmers from planning to implementation and considering their socio-cultural context is crucial for the success and sustainability of training programs.

Objective 3: evaluating the impact of the developed training approach on the productivity and income of smallholder maize farmers in Mashonaland Central Province

Evaluating the impact of the developed training approach on the productivity and income of smallholder maize farmers in Mashonaland Central Province is crucial to understanding its effectiveness. Utilizing closed questions, participatory rural appraisal, preference ranking, nominal group discussions, and matrix scoring, combined with descriptive and inferential statistics, binary logistic regression, and Chi-square tests analyzed through SPSS version 20, provides a robust methodological framework for this evaluation.

Training approaches such as Master Farmer Training (MFT), Farmer Field Schools (FFS), and Field Days have been preferred over newly introduced methods. Among these, FFS was identified as the most effective, significantly increasing output for both farmers and extension officers based on data from 2015 to 2017. At the Negomo irrigation scheme, the FFS approach led to high maize yields, which were sold as green mealies, resulting in increased income for farmers. This increase in income translated into improved livelihoods, evidenced by better housing, sanitation, asset acquisition, and the ability of families to afford two to three meals per day.

Farmer Field Schools had a more substantial impact than other training methods due to their participatory, hands-on learning approach that enhances both cognitive and psychomotor skills. This method aligns with the preference for demonstrations over theoretical instruction. Despite its success, demonstration plots were underutilized across all schemes. Given Zimbabwe's reliance on agricultural imports in recent years and the reduction in exports since 2000, developing irrigation and effective training methods like FFS is critical. Farmers trained through FFS consistently achieved higher yields than those who attended MFT, Innovation Platforms, and Field Days.

However, challenges persist, such as inadequately trained extension officers who may not deliver training effectively. Without promoting participatory approaches, farmers may develop a dependency on donor-driven projects, undermining their self-esteem and sense of ownership. A lack of hands-on training results in fewer tangible outcomes and reduced production. Additionally, insufficient monitoring by relevant departments can lead to complacency among farmers and extension officers. The success of FFS highlights the need for its encouragement and improvement to achieve better yields and sustain agricultural productivity in the region.

Farmers' strong preference for FFS underscores the importance of improving and promoting this approach to enhance yields. By addressing the identified challenges and building on the success of FFS, stakeholders can ensure that the training approach not only increases productivity and income but also contributes to the overall development and resilience of smallholder maize farmers in Mashonaland Central Province.

Objective 4: To assess the effectiveness of the developed training approach in improving the knowledge and skills of smallholder farmers in the use of irrigation technologies for maize farming

Assessing the effectiveness of the developed training approach in improving the knowledge and skills of smallholder farmers in using irrigation technologies for maize farming is crucial for sustainable agricultural development. Self-assessment, participant observation, and brainstorming were utilized to gather comprehensive insights into the training's impact. High-capacity building among smallholder farmers has demonstrably improved household output and income security, indicating the potential of the training approach to enhance livelihoods.

The introduction of Learning, Doing and Teaching (LDT) training aids has significantly contributed to farmers' decision-making, good farm management, resource allocation, and the cultivation of high-value crops. These improvements have led to better standards of living for many farmers. However, skills gaps remain a significant challenge. Despite the training, many farmers lack comprehensive marketing strategies and links, resulting in produce perishing before reaching the marketplace. This skills gap can be attributed to limited access to training opportunities and the absence of tailored programs that address the specific needs of smallholder farmers. Thus, capacitating farmers with soil fertility and water management skills, as well as compulsory bookkeeping training for those venturing into farming as a business, is essential.

The effectiveness of training programs is influenced by the varying cognitive levels among participants. Instructional methods and materials must accommodate the different mental capacities and ages of participants, and the language used must be user-friendly to ensure everyone benefits. Failure to link cognitive and psychomotor domains can result in low outputs in irrigation schemes. If training methods are not effective or memorable, participants may revert to old practices, leading to low adoption rates of new technologies.

Moreover, the lack of appropriate adult learning materials and methods can hinder effective learning. Improper scheduling of irrigation can cause conflicts, resulting in plant wilting and hampering overall progress. Furthermore, the capacity enhancement of extension officers is crucial, as

their lack of first-hand experience poses significant challenges. Without adequately trained extension officers, the effectiveness of the training approach is compromised, and farmers may not receive the support they need to fully utilize irrigation technologies.

In conclusion, while the developed training approach has shown promise in improving the knowledge and skills of smallholder farmers, addressing the identified gaps is essential. Ensuring that training programs are inclusive, context-specific, and tailored to the needs of adult learners will enhance their effectiveness. Additionally, improving the capacity of extension officers and ensuring proper resource allocation and scheduling can further bolster the positive outcomes of the training. By doing so, the training approach can significantly contribute to the sustainable productivity and income security of smallholder maize farmers in Mashonaland Central Province.

6.3 Research Summary

The learning domain theory provides a theoretical framework that can inform the development of effective training programmes for smallholder farmers. As spelt out in the theory, learning occurs within a specific domain, which is characterised by a set of interconnected concepts, procedures, and principles. The establishment of the training programmes that incorporate various learning domains, such as cognitive, affective, and psychomotor, result in greater knowledge acquisition among smallholder farmers

Farmers participating in maize farming with varied experiences were investigated. There were trained and untrained farmers. The results indicate a high-capacity building among farmers in the smallholder irrigation schemes improves household output and income security. The LDT training improves farmers' decision-making on good farm management that pertains to crop intensity, resource allocation and the cultivation of high value crops. Better standards of living were realised that included shelter, basic domestic and productive assets and diversified two to three meals per day.

The mostly attended training sessions were to do with pest management, post-harvest management and farming as a business. Marketing strategies and links are shortcomings in the farming communities especially at Chimhanda where their produce perished due to lack of markets. The study revealed inadequate skills among smallholder farmers identified as a major constraint to increasing agricultural productivity in Mashonaland Central Province. The lack of skills could be attributed to the limited access to training opportunities and the absence of appropriate training programmes that meet the needs of smallholder farmers. Issues of improved soil fertility and water management are still to be embedded in the farmers. Training in production and conservation aspects improves farmer adaptation to different shocks as posed by the climatic variations.

Zimbabwe's agricultural exports have reduced since 2000 and the country was heavily reliant on imports in the 2015 and 2019 seasons. The generality of farmers received training in Master Farmer Training, Farmer Field School, and ToT. These training approaches have a wide coverage reaching the remotest parts of the country while catering for many farmers at the same time. The study revealed that the top-down approaches of training failed as farmers preferred participatory method of agricultural extension. Adoption levels were affected by lack of understanding of the taught material. The low level of skills among smallholder farmers in

Mashonaland Central Province is attributed to a lack of formal education, training, and extension services. Most smallholder farmers in Zimbabwe have only basic education and have limited access to training and extension services. This makes decision-making a problem as farmers waver on whether to adopt new approaches or to revert to the old ways due to lack of comprehension and fear of loss.

All farmers participating in irrigated maize farming in all the schemes were invited to attend the trainings. However, not all of them participated citing various reasons. Of major concern was that some farmers could not attend as the trainings were ill–timed. In the context of smallholder maize farming in Mashonaland Central Province, there is a need for a training approach that is tailored to the specific needs and constraints of smallholder farmers. Such an approach has the potential to significantly improve the productivity and income of smallholder maize farmers in this province, and to contribute to the development of sustainable agriculture and rural livelihoods in Zimbabwe. Farmers will eventually accept the trainings if they are properly aligned to their needs.

As spelt out in the findings, the inadequacy of skills levels among farmers was compounded by inadequate teaching and learning materials. The effectiveness of these interventions was often limited by inadequate funding, lack of resources, and insufficient coordination among stakeholders. The parent agricultural ministry was falling short of resources to cover the agricultural extension services. There is, however, a need to develop innovative approaches to enhance the skills of smallholder farmers in irrigated maize farming.

The study revealed that extension officers were de-motivated by their working conditions that included meagre salaries, inadequate accommodation, lack of transportation, poor equipment and materials. It was impractical for one to walk for 30 km every day and be found at the station daily. Most cycles previously allocated to extension officers, had broken down hence, officers resorted to selected days especially Wednesdays to schedule trainings since it was `*chisi'*. Those willing to attend were able to participate. Extension officers indicated that no refresher courses on new innovations and technologies were afforded them.

Majority of participants preferred Master Farmer Training, Farmer Field Schools and Field Days respectively. The least preferred were the Innovation Platforms. Although most participants indicated preference of MFT over other methods, EOs highlighted that MFT needed revision as it had its weaknesses. Of the three approaches, FFS proved to yield better

results when applied than the MFT implying that it is a better approach to use. Farmer field schools are a participatory approach where farmers learn by practicals on their own plots thereby enhancing cognitive and psychomotor domains. To this end, Farmer Field Schools was deemed to be the best current approach to use for increased output in the smallholder maize irrigated schemes. For example, during the 2015-2017 cropping season, Negomo had a very good maize output. The cereal was sold as green mealies as it fetched more money than delivering to GMB. The effectiveness of a training approach depends on factors such as the content of the training, the delivery methods, and the context of the farming communities. That is why, there is need to explore alternative training approaches that are tailored to the specific needs and circumstances of smallholder farmers involved in irrigated maize faming.

The level of skills of farmers involved in irrigated maize farming is an essential factor that determines their capacity and performance. Smallholder farmers often lack access to education and training opportunities leading to limited skills and knowledge on sustainable farming practices. As a result, the application of appropriate irrigation technologies, use of quality inputs, and adoption of modern farming techniques is hindered, leading to low productivity and income.

Of the trainings offered, bookkeeping was shunned by many participants even though it is an essential training towards becoming a successful farmer. This could be attributed to low farmer educational levels. It was noted that most the farmers partially remembered what they were taught. The instructional method used was not in line with the age and grasping capacity of the participants as the training started with theory then group demonstrations on a chosen plot that took place after a very long time. The delay was caused by lack of inputs. Cognitive and psychomotor domains should be linked for better reasonable outputs to move from subsistence farming to farming as a business. There was also no monitoring by the extension personnel or other stakeholders on the practicals undertaken on individual plots.

Farmers in Chimhanda and Negomo regarded skills obtained through trainings to be important in irrigated maize production. They indicated the timely adoption of the new practices as a factor thereby confirming the applicability of the affective domain that makes people change behaviour. Adoption levels were at 26 % whilst partially adopted was at 52%. This could be attributed to the group training method without age, gender and cognitive segregation. Some farmers missed trainings due to adult competing roles. That is why any training should be well

timed so that it gets the full support of the community. Group training method is the best method for adult learning as it is more informal than formal, and people share experiences.

Although marketing linkages strategies are critical factors that affect the effectiveness of training programmes, these were lacking in the remotely placed scheme Chimhanda. There were problems with marketing as farmers failed to deliver their produce to major markets like Mbare Musika. They could not form groups to cut transportation costs. The farmers lacked water management skills thereby causing conflicts in the irrigation schemes especially in Chimhanda as some sprinklers were not working. The newly acquired centre pivot was lying idle for over two years as no one was able to mount the equipment. The study confirms the importance of training all scheme members in the operation and maintenance of irrigation equipment to avert such problems. The lack of knowledge on efficient use of water resources by smallholder farmers lead to inefficient irrigation practices.

Extension officers highlighted the need for refresher courses and contact visits to other successful agricultural institutions outside the country to assess how extension services are carried out. They wanted to have a first-hand experience with the new innovations and technologies. Chief among the skills requirements was computer literacy courses. Provision of equipment such as enough computers and materials to use in the training of agricultural extension programmes were also requested. The parent Ministry needs to fully resource ARDAS in terms of teaching and learning materials and to look into employee welfare socially and economically for effective extension services.

Recommending an improved framework for training in irrigated maize farming

There is no one approach that is suitable for all agricultural training situations as there are advantages and disadvantages associated with a single entity. Examination of current training approaches indicated differences in yields.

A framework that uses experiential learning methods is recommended for smallholder farmers. The experiential learning approach enables farmers to learn by doing, which is more effective than simply reading or listening. The experiential learning methods provide farmers with hands-on training in all aspects of irrigated maize farming. This approach enables farmers to gain practical skills for immediate application in their farming.

The framework also includes the use of peer-to-peer learning. Peer-to-peer learning involves farmers learning from each other, sharing their experiences, and supporting each other in their farming activities. This approach is particularly useful in rural communities where farmers face similar challenges and can learn from each other's successes and failures. Peer-to-peer learning is facilitated by the formation of farmer groups that are encouraged to share knowledge and skills and support each other. Peer-to-peer learning can be done through field days and look and learn tours. For example, farmers toured a mango plantation in Negomo. This was a new initiative and other farmers appreciated. To this end Farmer Field School was found to yield better results as it is a participatory method and was preferred by participants as farmers acquired knowledge and experience whilst working in their fields. The broader the knowledge and skills base the more production and quality of output.

The framework also involves the use of extension services. Extension services provide farmers with information and guidance on the latest technologies and practices in irrigated maize farming. Extension services can include the provision of information, technical advice, and access to inputs and markets. The agricultural extension services can be delivered by trained extension officers who will work with farmers to identify their specific needs and provide them with the necessary support. Furthermore, efforts to improve access to extension services should include the use of mobile extension services for the enhancement of FFS. Extension agents are the linking pins between agricultural research organisations and the farmers therefore, upgrading the efficiency and quality of agricultural extension services is recommended.

FFS was noted to have worked well in the irrigation schemes as it fills the gap in extension services and is farmer oriented. In applying this method, farmers can work independently but with the disadvantage of instilling over confidence in participants as found out in Negomo. Farmer Field Schools were recommended by both extension officers and farmers for use in irrigated maize farming though with the disadvantage of contact time requirements. Personnel involved in the three irrigation schemes studied advocated for the use of FFS as a method of training. However, this approach should be strengthened in all schemes to enhance capacity building for improved production. When planning for farmer training programmes, implementers should consider how people learn as people are born with different mental capacities for learning. Transfer of knowledge is affected by the degree to which people learn and understand facts to be able to follow procedures. It is better to extensively educate people than to train them to perform a particular task. The process in turn motivates farmers to learn

and to appreciate the amount of time spent learning. This consideration motivates different farmer age groups to learn when they see the impact of the knowledge gained on their daily lives. Young farmers can therefore, be lured to join farming as a form of living.

Overall, an improved learning domain-based framework for training farmers in irrigated maize farming has the potential to improve the productivity and income of smallholder farmers in Zimbabwe. By providing farmers with the knowledge and skills they need to succeed, this framework could help to support sustainable and inclusive agricultural development in the country. Programmes should be tailor made and be context specific to meet the needs of the smallholder farmers.

6.4 Conclusions

Farmers in Negomo, Eben and Chimhanda Schemes were a mixed bag of trained and untrained participants. Farmers favoured pest management, post-harvest and farming as a business training as the methods elevated them from subsistence to viability farming. It was discovered that the cognitive, affective and psychomotor domains have an effect on the farmer productivity. Smallholder farmers who received training had improved skills and knowledge resulting in increased yields. However, a skills gap still existed as farmers lacked knowledge in proper record keeping, soil fertility and water management. Extension officers resorted to using vernacular language during teaching and learning sessions. There were, however, moments when some technical jargon could not be translated into vernacular leaving the farmer not fully understanding the teaching. The language used and lack of teaching and learning aids such as visual aids, handouts (pamphlets), flip charts, markers, films and videos posed as barriers to most training sessions. This meant that some vulnerable groups such as the visually and hearing impaired were left out. Extension Officers failed to plug the skills gap as their interaction with farmers was minimal due to various factors related to social, economic and emotional resources.

Farmer Field School was ranked to be the best approach as it had increased output realisation by both farmers and extension officers basing on the 2015-2017 outputs. This is a participatory method that has worked well in other countries. Such a participatory approach is preferred as learning is by doing thereby enhancing the cognitive and psychomotor domains. Through its nature of non-formal education, the approach concretises the preference of demonstrations over theory.

There were skills gap in the knowledge of appropriate irrigation technologies and adoption of new farming practices leading to reduced productivity and income. This was particularly noted in Chimhanda which is the furthest and remotest scheme among the three schemes. Farmers had different mental capacities and educational levels that caused trainings to be difficult with most participants partially remembering the information. Bookkeeping was shunned by most farmers as it required high levels of cognitive domain. There was lack of monitoring and evaluation on individual practicals as EOs had transportation challenges. Knowledge related to marketing was found lacking and farmers did not have water management skills. Refresher courses for EOs should be availed. This can be done through contact visits. Extension Officers need to be capacitated with computer literacy skills and to be fully equipped and resourced for effective extension services.

Overall, the improved learning domain-based framework for training smallholder farmers in irrigated maize farming is a comprehensive approach that is designed to address the knowledge gaps and skill deficiencies of smallholder farmers in Mashonaland Central of Zimbabwe. The framework is characterised by its participatory approach, context-specificity, practical orientation, flexibility, and sustainability. The chosen FFS approach aims at enhancing the effectiveness of training and improving the performance of smallholder farmers in irrigated maize farming over the long term.

6.5 Recommendations for Policy and Development Practice

In Mashonaland Central, it was noted that agriculture performance and productivity had declined significantly as observed at Negomo, Eben and Chimhanda Irrigation Schemes. Smallholder farmers involved in irrigated maize farming require various skills to be able to carry out the farming practices effectively. The inability to link the cognitive, affective and psychomotor domains and several socio-emotional skills related to the ability of farmers to interact with other farmers and the wider community caused the drop in production. Previous studies have shown that smallholder farmers in Zimbabwe often lack the necessary skills to carry out irrigated maize farming. These factors were also established in this study. The challenges have negatively affected the performance of irrigated maize farming. In this section, guiding policy strategies and practice recommendations are presented considering the findings of this study.

1. *Combine old and new approaches*

A combination of old and new approaches to farmer training can be effective in increasing productivity and household income. For example, traditional methods such as farmer-to-

farmer knowledge sharing, and practical demonstrations can be combined with modern approaches such as digital tools and online training.

2. *Focus on practical skills*

Farmer training programmes should focus on practical skills that farmers can apply on their farms to increase productivity and improve their livelihoods. This includes skills related to crop and livestock production, marketing and financial management.

3. *Addressing gender and social inequalities*

Farmer training programmes should be designed to address gender and social inequalities and ensure that all farmers have equal access to training opportunities. This includes addressing cultural barriers and providing training in local languages to reach marginalized groups.

4. *Use participatory approaches*

Participatory approaches to farmer training, such as participatory rural appraisal and farmer field schools, can be effective in engaging farmers and promoting knowledge sharing and learning-by-doing.

5. *Monitor and evaluate impact*

It is important to monitor and evaluate the impact of farmer training programmes to ensure that they are achieving their intended outcomes. This includes measuring changes in productivity, income and food security, as well as assessing the sustainability of the programme over time.

Overall, a combination of old and new approaches, with a focus on practical skills, addressing gender and social inequalities, using participatory approaches, and monitoring and evaluating impact, can be effective in increasing productivity and household income and food security through farmer training programmes.

6.6 Contribution to the Body of Knowledge

The thesis contains several groundbreaking contributions to improving the effectiveness of training for smallholder irrigated maize farmers in Zimbabwe. Among them are the following:

a) Applies Bloom's Taxonomy of Learning Domains - The study rigorously applies Bloom's taxonomy of cognitive, affective and psychomotor domains to assess current training approaches. This provides a robust theoretical framework for developing

training programs that comprehensively build knowledge, attitudes and practical skills among farmers.

b) Identifies Farmer Field Schools as most effective - The research found that Farmer Field Schools (FFS) are the most effective current approach compared to Master Farmer Training (MFT) for increasing maize output in smallholder irrigation schemes. FFS proved superior to the top-down MFT approach that farmers found less engaging.
c) Highlights importance of tailored, participatory training - The study reveals that top-down training approaches failed as farmers strongly preferred participatory extension methods. Adoption was hindered by technical jargon and lack of understanding due to farmers' basic education levels. This underscores the need for training tailored to farmers' specific needs and delivered through interactive, hands-on methods.
d) Identifies key skills gaps and constraints - The research pinpoints critical skills gaps among farmers in areas like pest management, post-harvest handling, record-keeping, soil fertility and water management. It also highlights constraints like insufficient teaching materials, poor stakeholder coordination, and inadequate interaction between farmers and extension officers due to resource constraints.
e) Proposes a comprehensive framework for improving training - Based on the findings, the thesis puts forth a detailed framework for enhancing the effectiveness of farmer training programs. This includes incorporating learning domains into curricula, prioritizing practical training with visual aids, promoting sustainable farming practices, strengthening farmer-extension linkages, and investing in teaching aids and M&E.

Recommendations for Further Research

In the study, several areas for further academic research to build on its findings were identified. They include the following:

a) Conduct impact evaluations of the proposed learning domain-based training approach to rigorously assess its effects on farmer knowledge, skills, attitudes, adoption of technologies, yields and incomes.
b) Explore the use of digital technologies and farmer-to-farmer learning approaches to complement and enhance the effectiveness of traditional training methods.
c) Investigate the specific training needs and constraints of women farmers in irrigation schemes to design more gender-inclusive programs.

d) Analyze the cost-effectiveness of different training delivery models to inform resource allocation decisions by policymakers and development partners.
e) Assess the institutional capacity and training needs of agricultural extension systems to effectively implement the proposed learning domain-based approach.

Recommendations for Policy and Practice

The thesis provides several key recommendations for policymakers and development practitioners to improve the effectiveness of training for smallholder irrigated maize farmers:

a) Incorporate learning domain taxonomies into training curricula to ensure comprehensive skill development in cognitive, affective and psychomotor domains.
b) Prioritize practical, hands-on training sessions supplemented with visual aids to overcome language barriers and facilitate effective knowledge transfer.
c) Promote sustainable farming practices including integrated pest management and water-efficient irrigation technologies to enhance productivity while mitigating environmental impacts.
d) Strengthen collaboration between extension officers and farmers through regular outreach, mentoring, and support services. Facilitate peer-to-peer learning and knowledge exchange among farmers.
e) Allocate resources for developing and disseminating teaching aids to enhance training effectiveness and overcome communication barriers. Introduce robust monitoring and evaluation mechanisms.

REFERENCES

Abate, T., Shiferaw, B., Menkir, A., Wegary, D., Kebede, Y., Tesfaye, K., Kassie, M., Bogale, G., B., Girma, G., Tefera, T., & Keno, T. 2012. Factors that transformed maize productivity in Ethiopia. *Food Security*, 4(3), 313-323.

Abdullah, M., Xia, L.C., Li, J. &Ghazanfur, S. 2014. Effectiveness Comparison Between the Farmers Field School and the Training & Visit Approaches of Agricultural Extension in Two Districts of Pakistan. *American-Eurasian Journal of Agriculture and Environmental Sciences.* 14(**1):** 33-39.

Adejo, E.P. 2019. Women Participation in Post-Harvest Processing of Maize Using Indegenous Technologies. Department of Agricultural Economics, Kogi State University Anyigba.

Adeniyi, O.R., Ojo, A. 2013. Food security status of rural farming households in Iwo, Ayedire and Ayedaade Local Government areas of Osun State, South-Western Nigeria. African *Journal of Food, Agriculture, Nutrition and Development.* 13**(5):** 8209-8223.

Agbarevo, M.N. B. 2013. Farmers' Perception of Effectiveness of Agricultural Extension Delivery in Cross-River State, Nigeria*. IOSR Journal of Agriculture and Veterinary Sciences*. 2**(6)** 1-7*.*

Agrihome, 2018. Types of Irrigation: Advantages and Disadvantages. San Francisco, California. (Accessed 30 May, 2018).

AGRITEX, 2010. *Socio-Economic Impact of Smallholder Irrigation Development in Zimbabwe,* Ministry of Agriculture Mechanisation and Irrigation Development, Government Printers. 80p.

AGRITEX, 1999. In FAO Repository: *Socio-Economic Impact of Smallholder Irrigation Development in Zimbabwe:* Retrieved (17 February, 2014).

Agossou, N. 2020. Benefits of Investing in Agribusiness. Crowdfunding, Senegal.

Aker, J. C., Ghosh, I., & Burrell, J. 2016. The promise (and pitfalls) of ICT for agriculture initiatives. Agricultural Economics, 47(S1), 35-48.

Albizua, A., Laroque, E.M.G, Krause, R.W., Pacual, U.2021. Social networks influence farming practices and agrarian sustainability. PLoSONE 16(1):e0244619.

Anderson, L.W. & Krathwohl, D.R. (eds) 2010. *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. Ally & Bacon. Boston, MA (Pearson Education Group). 254p

Anderson, L.W., & Sosniak, L.A. 1994. *Bloom's Taxonomy: A Forty-Year Retrospective*. Chicago, Illinois.

Ardichvili, A., Page, V., & Wentling, T. 2013. Motivation and barriers to participation in virtual knowledge-sharing communities of practice. *Knowledge Management*. 7(**1)**:64-77.

Asiabaka, C. 2015. Promoting Sustainable Extension Approaches: Farmer field School (FFS) and its role in sustainable agricultural development in Africa. *Journal of Agricultural Extension.* 3**(1)** 18-25.

Averbeke, W. Van & Mohamed, S.S. 2012. *Smallholder Irrigation Schemes in South Africa: Past, Present and Future.* Tshwane University of Technology, South Africa.

Bachhv, N.B. 2012. Information needs of the rural farmers: A study from Maharashtra, India; A survey, Library Philosophy and Practice. Accessed (11 December 2018).

Bagson, E., & Kuuder, C.J. 2013. Assessment of a Small-scale Irrigation scheme in household food security and leisure in Kokoligu; Ghana. *Research on Humanities and Social Sciences*. 3**(1**):17-26.

Baffoe-Asare, R. 2013. Socio-economic Factors Influencing Adoption of Codapec and Cocoa High-Tech Technologies among Smallholder Farmers in Central Region of Ghana. Am.J. Exp. Agric.3. 277-292. https://doi.org/10.9734/AJEA/2013/1969.

Battilani, A. 2012. Sustainable Knowledge-based Irrigation Management: The IRRINET Package: *Irrigation Drainage Systems*. **18.** 275-297.

Bandura, A. 1977. Social learning theory. Engelwood Cliffs, NJ: Prentice Hall.

Benard, R; Dulle, F; & Ngalapa, H. 2014. "Assessment of information needs of rice farmers in Tanzania; A case study of Kilombero District, Morogoro. Library Philosophy and Practice (e-journal). 1071.

bendra Jha, J. 2018. *Communication Approaches in Agricultural Extension Programmes of Nepal, Their Achievements and Limitations*. Tribhuvan University, Department of Microbiology, Academia 2018.

Berman, E. A. 2017. "An Exploratory Sequential Mixed Methods Approach to Understanding Researchers' Data Management Practices at UVM: Integrated Findings to Develop Research Data Services." *Journal of eScience Librarianship*. 6**(1):** e1104.

Bezabih, M., Holden, S. T., & Mannberg, A. 2017. The role of land certification in reducing gaps in productivity between male- and female-owned farms in rural Ethiopia. Journal of Development Studies, 53(7), 1065-1081.

Bhalage, P., Jadia, B.B., & Sangale, S.T. 2015. Case Studies of Innovative Irrigation Management Techniques: International Conference on Water Resources, Coastal and Ocean Engineering (ICWRCOE). *Aquatic Procedia***4:** 1197-1202.

Binala, L. 2016. Irrigation Cooperative as Strategy of Peri-urban Poverty Reduction: Case Study of Ward 5 in Epworth, Harare. P55-66. In: Chirisa, I.; Mazhindu, E. and Bandauko, E. (editors), *Peri-urban Developments and Processes in Africa with Special Reference to Zimbabwe.* Springer International Publishing.

Bingen, J., & Sanginga, P. 2019. Learning alliances and agricultural innovation: Case studies from Zimbabwe. Routledge.

Blanche, T. M., Durrheim, K & Painter, D. 2012. Research in Practice: *Applied Methods for Social Sciences.* University of Cape Town, Cape Town, South Africa. 594p.

Bloom, B.S. 1956. *Taxonomy of Educational Objectives. The Classification of Educational Goals, Handbook I: Cognitive Domain*. New York Longman Publishing Group.

Bransford, J.D. 2000. *How People Learn: Brain, mind, experience and school (expanded edition).* Sciences Engineering Medicine: The National Academic Press. 828pp.

Brown, K. 2011. Sustainable adaptation: An Oxymoron? *Climate and Development*. **31:** 21-31.

Bryman, A., & Bell, E. 2007. Business Research Methods, 2nd edition, Oxford New York: Oxford University Press.

Bush, B. 2018. What motivates adults to learn? Ausmedcorporate, USA.

Businessballs, 2017. Benjamin Bloom's Taxonomy of Learning Domains – Cognitive, Affective, Psychomotor Domains – design and evaluation toolkit for training and learning. Retrieved (27 February 2017).

Butt, T., Gao, Q. & Yousuf Hussain, M. 2015. An Analysis of the Effectiveness Farmer Field School (FFS) Approach in Sustainable Rural Livelihood (SRL): The Experience of Punjab-Pakistan. *Agricultural Sciences***. 6:** 1164-1175.

Chapoto, A., Jayne, T. S., & Zulu, B. 2011. Who gets subsidies? The distribution of fertilizer and maize seed subsidies in Malawi. Food Policy, 36(2), 266-275.

Chauhan, J. 2007. *Agriculture Extension Education: Communication in Agriculture*. R.B.S. College, Bichpuri, Agra.

Chazovachii, B. 2012. The Impact of Small-Scale Irrigation Schemes on Rural Livelihoods: The Case of Panganai Irrigation Scheme, Bikita District, Zimbabwe. *Journal of Sustainable Development in Africa* 14**(4)**:217-231.

Chigumira, E., & Mujere, N. 2009. Variability of urban water supply and demand. In Feyen, Shannon and Neville (eds*): Water and Urban Development Paradigms: Towards an Integration of Engineering.*

Chipindu, B., Mugabe, F. T., Chivenge, P., & Mapfumo, P. 2018. Participatory training design and evaluation approach for sustainable soil and land management practices. Land Use Policy, 79, 904-913.

Chivuraise, C., Chamboko, T., & Chagwiza, G. 2016. An Assessment of Factors Influencing Forest Harvesting in Smallholder Tobacco Production in Hurungwe District, Zimbabwe: An Application of Binary Logistic Regression Model.

Christoplos, I. 2010. *Mobilising the Potential of Rural and Agricultural Extension*. Office of Knowledge Exchange, Research and Extension, Food and Agricultural Organisation of the United Nations and Global Forum for Rural Advisory Services, Rome.

Clark, D. 2015. Bloom's Taxonomy of Learning Dormains: The Cognitive Domain.http://www.nwlink.com/~donclark/hrd/bloom.htm. Accessed (15 June, 2015).

Community Development Alliance Scotland. 2018. How Community Development Happens: Why Stronger Communities matter and what it takes to Develop them. http://communitydevelopmentalliancescotland.org/about-cdas/p. Accessed (4 March2018)

Creswell, J.W. 2012. *Qualitative Inquiry and Research Design, Choosing Among Five Approaches*. Thousand Oaks: Sage Publications.

Danso-Abbeam, G., Ehiakpor, D.S., Aidoo, R. 2018. Agricultural extension and its effects on farm productivity and income: insight from Northern Ghana. *Agric. Food Secur.* 7, **74.** https://doi.org/10.1186/s40066-018-0225-x

Djurfeldt, A. A., Holmén, H., & Jirström, M. 2017. African smallholder agriculture in regional and global food value chains: Agricultural commercialisation, impacts and pathways. Routledge.

Dossah, B.O., Bashir, D. Ndahi, A.K. & Ahmed, S.D. 2003. Training Needs for successful development of Irrigation Scheme. *29th WEDC International Conference: Towards the Millennium Development Goals. [Accessed 1 December 2015].*

Fanadzo, M, Chiduza, C. & Mnkeni, P.N.S. 2010. Overview of smallholder irrigation schemes in South Africa: Relationship between farmer crop management practices and performance. *African journal of Agricultural Research.* 5**(25)**:3514-3523. Accessed (1 December 2015).

Feder et al., 2004, G., Just, R.E., Zilberman, D., 2015. Adoption of Agricultural Innovations in Developing Countries: A Survey. *Econ. Dev. Cult. Change* **33,** 255–298.

Feder et al., 2004, G., Murgai, R. & Quizon, J.B. 2004. The Acquisition and Diffusion of Knowledge: The Case of Pest Management Training in Farmer Field Schools, Indonesia. *Journal of Agricultural Economics.* 55**(2**): 221-243.

Ferroni, M and Zhou, Y. 2012. Achievements and Challenges in Agricultural Extension in India. *Global Journal of Emerging Market Economies.* 4**(3)** 319-346.

Food Access Network. http://www.sustainweb.org/foodaccess/. Retrieved (19 July, 2017).

Food and Agricultural Organisation of the United Nations. 2019. Irrigation in Africa in figures: AQUASTAT Survey 2018. FAO.

Food and Agricultural Organisation of the United Nations. 2017. Zimbabwe: Country Programming Framework 2017-2020. FAO.

Food and Agricultural Organisation. The State of Food Insecurity in the World, 2015. FAO Repository.

Food and Agriculture Organisation 2010. *Socio-Impact of Smallholder Irrigation Development in Zimbabwe*. FAO Repository. Accessed (3 December, 2015).

Food and Agriculture Organisation Report No. 99/030 1999. Smallholder Irrigation Development Project. **(1):** 17-49.

Freire, P. 1980. *Pedagogy of the Oppressed.* Herder and Herder, New York, 186p.

Gamucio, S. 2011. The KAP Survey Model: Knowledge, Attitude & Practices: ICG Communigraphie, France. *International Journal of Environmental Research and Public Health.* 12**(2)**: 1834-1848.

Gebregziabher, G., Namara, R. E., Holden, N. M., Awulachew, S. B., & Alemaw, B. F. 2018. Can irrigation efficiency be improved in water stressed regions? Evidence from Ethiopia. Agricultural Water Management, 195, 1-11.

Ghasemi, A., Zahediasl, S. 2012. Normality Tests for Statistical Analysis: A Guide for Non-Statisticians. *Int. J. Endocrinol. Metab.***10**: 486–489. https://doi.org/10.5812/ijem.3505

Giller, K. E., Witter, E., Corbeels, M., & Tittonell, P. 2011. Conservation agriculture and smallholder farming in Africa: the heretics' view. Field crops research, 124(3), 229-230.

Gondwe, T.M., Alamu, E.O., Musonda, M., Geresomo, N., & Maziya-Dixon, B. 2017. The relationship between training farmers in agronomic practices and diet diversification: a case study from an intervention under the Scaling up Nutrition Programme in Zambia. *Agriculture and Food Security* 6**(72**)

Google Maps, May 2015.

Government of Zimbabwe, 2014. *The 2014 Mid-year Fiscal Policy Review Statement. "Towards an Empowered Society and a Growing Economy" Presented to the Parliament of Zimbabwe.*

Government of Zimbabwe, 2019. Country Food Status Report. Government Printers, Harare.

Government of Zimbabwe. 1997 ZIMPREST: *Zimbabwe Programme for Economic and Social Transformation 1996-2000*. Government Printers, Harare, Zimbabwe.

Grunfeld, H., & Hoon Ng, M.L. 2013. e-Infrastructure and e-Services for Developing Countries: *5th International Conference, AFRICOMM 2013, Blantyre, Malawi, November 25-27. Springer books.*

Haggblade, S., Hazell, P., & Dorward, A. 2010. The rural non-farm economy: Prospects for growth and poverty reduction. World Development, 38(10), 1429-1441.

Hanson W.E, Creswell J.W., Clark V.L.P., Petska K.S., & Creswell J.D. 2005. Mixed methods research designs in counselling psychology. *Journal of Counselling Psychology.***52:** 224–235.

Hanyani-Mlambo, B.T, 2013. Strengthening the Pluralistic Agricultural Extension System: A Zimbabwean Case Study. *Agricultural Research Council (ARC) Zimbabwe*. **34**: 20-35.

Hawkins, H.S., Dunn, A.M., & Cary, J.W. 1982. *Agricultural and Livestock Extension. Volume 2. The Extension Process.* Hedges & Bell, Pvt Ltd, Melbourne.

https://doi.org/10.3390/su9091524

Hlongwane, J. P., & Mushunje, A. 2019. Can smallholder farmers increase maize yield through training programmes in Zimbabwe? Agrekon, 58(4), 431-443.

Hove, L., Chidoko, P., &Mvumi, B. M. 2019. Smallholder farmer access and utilization of irrigation services in semi-arid Zimbabwe. Irrigation and Drainage, 68(2), 227-236.

Indeed.Com March, 18, 2021. Farmer Skills and Definition.

International Fund for Agriculture Development 2021. FAO, Rome.

Jona, C.N., & Terblanché, S.E. 2015. Farmers' Perception on Contact Frequency, Adequacy, Relevance and Quality of Agriculture Support Services (ASS) in Oshikoto Region in Namibia. *South African Journal of Agricultural Extension.* 43**(1**): 107 – 121.

Jongwe, A. 2014. Synergies between urban agriculture and urban household food security in Gweru City, Zimbabwe. *Journal of Development and Agricultural Economics*. 6**(2**):59-66.

Kamwi, J. 2019. Evaluating effectiveness of extension approaches on crop productivity and livelihoods of smallholder farmers: A review of empirical studies in Zimbabwe. African Journal of Agricultural Research, 14(26), 1355-1363.

Kangara, G.; Chamboko, T.; Muwaniki, C. & Siziba. S. 2021. *Re-imagining Agricultural Extenson through a Learning Lens (RAELL)- Zimbabwe Report,* RAELL Project.

Kanyama-Phiri, G., Siziba, S., & Makate, C. 2018. The political ecology of FISP in Malawi: Insights from the Bwanje Valley Irrigation Scheme. Journal of Political Ecology, 25(1), 455-473.

Karoro, D. 2021. Zimbabwe Broadcasting Corporation (ZBC) Report. March, 11, 2020. Harare.

Kaufman, R., & Keller, J.M. 1994. Levels of Evaluation: Beyond Kirkpatrick. *Human Resources Development Quarterly,* 5**(4):**371-380.

Kaur, K. and Kaur, P. 2018. Agricultural Extension Approaches to Enhance Knowledge of Farmers. International Journal of Current Microbiology and Applied Sciences.2319-7706 Volume 7 Number 02.

Kenny, S., & Connors, P. 2017. *Developing Communities for the Future* (5th ed.). South Melbourne: Cengage Learning Australia.

Keita, N., Okidegbe, N., Cooke, S., & Marchant, T. 2009. *WYE City Group on Statistics on Rural Development and Agricultural Household Income*: 2nd Meeting, Italy, Rome 11-12 June 2009, FAO Headquarters, 18p.

Khisa, G. 2021. Farmers Field School Methodology: Training of Trainers Manual 1st Edition. FAO, Kenya.

Knowles, M. 1980. *The Modern Practice of Adult Education.* New York, Association Press. 384p.

Kothari, C. R., & Garg, G. 2014. *Research Methodology: Methods and Techniques*, 449p.

Labour & Economic Development Research Institute (LEDRIZ) & Zimbabwe Congress of Trade Unions (ZCTU), 2012. ISBN: 978-1-77922-203-9.

Langemeier, M. And Boehlje, M. 2018. "What Skills and Competencies Do I need to Grow?" *farmdoc daily* (8):17, Department of Agricultural and Consumer Economics, University of Illinois.

Levidow, L., Zaccaria, D., Maia, R., Vivas, E., Todorovic, M. & Scardgno, A., 2015. Improving water-efficient irrigation: Prospects and difficulties of innovative practices. *Agricultural Water Management.* ***140*:** 84-94.

Lukuya, B., Place, F., Franzel, S. & Kiptot, E. 2012. Disseminating Improved Practices: Are Volunteer Farmer Trainers Effective? *The Journal of Agricultural Education and Extension.* 18**(5):** 525-540. Retrieved (20 January, 2015).

Luo, X., Zhang, Q., Yin, J., Li, X., & Li, J. 2018. Effects of cognitive and affective learning domains on rural residents' energy-saving behaviour in China. Journal of Cleaner Production, 182, 492-503.

Magcawas, A.G. 2016. Agricultural Extension and Communication. STARRDEC, New York.

Makate, C., Makate, M., Mango, N., & Nyikahadzoi, K. 2016. Climate variability and household food security: The adoption of smallholder irrigation in Zimbabwe. Agricultural Water Management, 168, 36-44.

Mapfumo, P., Utete, B., Moyo, P., & Mupangwa, W. 2020. Climate-smart agriculture in Zimbabwe: A review. International Journal of Agricultural Sustainability, 18(3), 213-225.

Makoye, K. 2013. SMS weather advice cushions Tanzanian farmers from drought. Thomson Reuters Foundation.

Manyena, S. B., Moyo, P., & Ncube, S. 2015. The effectiveness of training in sustainable agriculture practices: A case study of smallholder farmers in the Eastern Cape Province, South Africa. Journal of Human Ecology, 51(1-2), 71-77.

Masikati, P., Homann-Kee Tui, S., Descheemaeker, K., Crespo, O., Walker, S., Lennard, C., & Giller, K. E. 2017. Food and cash crop choice and net income in smallholder agriculture: the case of semi-arid Zimbabwe. Agricultural Economics, 48(3), 311-322.

Mashingaidze, A. B., Katsaruware, R. T., & Mangadze, T. A. 2016. The influence of indigenous knowledge systems on the design and implementation of sustainable agriculture

training programmes in Zimbabwe. Journal of Agricultural Education and Extension, 22(3), 259-273.

Maslow, A. 1943. Theory of Human Motivation. *Psychological Review* 50**(4)**:370-396.

Matondi, P. B., Odendo, M., & Dzingirai, V. 2017. How market information systems can drive farmer entrepreneurship in Africa: Experiences from Zimbabwe. The Electronic Journal of Information Systems in Developing Countries, 80(1), 1-15.

Mawere, M., Kunzekweguta, M., & Muzamba, M. 2018. A review of the impact of climate variability and climate change on the rain-fed agriculture sector in Zimbabwe. Journal of Agriculture and Rural Development in the Tropics and Subtropics (JARTS), 119(2), 147-164.

Mazvimavi, K., Twomlow, S., & Hove, L. 2013. Improving maize productivity and profitability using conservation agriculture in Zimbabwe: A policy analysis. Agricultural Systems, 118, 38-50.

Max-*Max-Neef* , M. 1994. *From the Outside Looking In: Experiences in Barefoot Economics*. ZED Books, London, 208p.

Mbiba, B. 1998. *Urban Agriculture in Harare: Between Suspicion and Repression*. Africa Research Institute.

Mbure, G. And Clare, S. 2017. *Improving the Management of Agriculture Demonstration Sites in Food Security Programmes: A Practitioner's Guide.* World Vision US. 300 I Street NE Washington DC., 200002, USA.

Mbwana, H.A., Kinabo, J., Lambert, C., & Biesalski, H.K. 2016. Determinants of household dietary practices in rural Tanzania: Implications for nutrition interventions. *Cogent Food & Agriculture***2**:1224046.

McCarty, L. 2015. Maize/Corn. Feedfuture Newsletter. Ethiopia. American Educational Research Association. Retrieved (21 August 2016)

Mhlanga, B., Mhaka, F., & Ncube, N. 2020. Smallholder farmers' access to information and communication technologies (ICTs): Experiences from Zimbabwe. Journal of Rural Studies, 80, 319-327.

Miiro, R.F., Matsiko, F.B., & Mazur, R.E. 2013. Training and Farmers' Organisations' Performance. Journal of Agricultural Education and Extension 2013, *1-14, iFirst.* Retrieved (20 September 2015).

Mika, H.P., & Mudzimiri, N. 2012. The Impact of Master Farmer Training Scheme on Crop Productivity of Communal Farmers in Gutu District. *International Journal of Mathematical Archive (IJMA)*. 3**(3):** 849-854. Retrieved (16 May, 2015).

Ministry of Agriculture, Lands, Fisheries, Water and Rural Development (MALFWRD) 2022 Report: Government of Zimbabwe. Government Printers, Harare.

Ministry of Agriculture, Lands, Fisheries, Water and Rural Development (MALFWRD) 2020 Report: Government of Zimbabwe. Government Printers, Harare.

Ministry of Agriculture Mechanisation and Development (MoAMID) 2014 Report: Government of Zimbabwe. Government Printers, Harare

Ministry of Agriculture Mechanisation and Irrigation Development 2012. Government Printers. 80p.

Mkumbwa, S., Mpanda, M., & Kibusi, T. 2018. Explaining farmers' uptake of improved maize seed in Tanzania using the social learning approach. African Journal of Agricultural Research, 13(16), 781-792.

Mlambo, A.S. 1987. *The Economic Structural Adjustment Programme: The Case of Zimbabwe, 1990-1995*. University of Zimbabwe Publications, Harare, Zimbabwe.

Moyo, P., Mupangwa, W., Nhapi, I., & Dimes, J. 2020. Smallholder irrigation in Zimbabwe: Current status and future opportunities. Water International, 45(2), 156-174.

Moreno-Pizani, M.M. 2021. Water Management in Agricultural Production, the Economy and Venezuelan Society. USAID Report.

Mudombi, S. 2013. Adoption of Agricultural Innovations: The Case of Improved Sweet Potato in Wedza Community of Zimbabwe. *African Journal of Science, Technology, Innovation and Development*. 5**(6)**: 459-467.

Mugabe, F. T. 2015. Evaluating the effectiveness of agricultural extension programmes in Zimbabwe. Journal of Agricultural Extension and Rural Development, 7(6), 197-203.

Mujeyi, B., Mapfumo, P., Nyikahadzoi, K., & Mutenje, M. J. 2017. Gender-specific determinants of adoption of conservation agriculture by smallholder farmers in Zimbabwe. Agricultural Systems, 157, 305-315.

Muller, I., Guenat, D. & Fromm, I. 2010. Impact Monitoring and Evaluation System for Farmer Field Schools in Kyrgzstan: *How to Optimize Resource allocation for Higher Impact. Conference on International research on Food Security, Natural Resource Management and Rural Development: T*ropentag, ETH Zurich, September 14-16.

Mupangwa, W., Twomlow, S., Walker, S., & Hove, L. 2019. Conservation agriculture for climate-resilient agriculture in Zimbabwe: A review. Agronomy, 9(7), 384.

Mupaso, N., Manzungu, E., Mutambara, J., & Hanyani-Mlambo, B. 2014. The Impact of Different Irrigation Technologies on the Economic Performance of Smallholder Irrigation Schemes in Zimbabwe. *Irrigation and Drainange*. (63**):4.** Doi:10.1002/ird.1820.

Mutambara, S. & Munodawafa, A. 2014. Production challenges and sustainability of smallholder irrigation schemes in Zimbabwe. *Journal of Biology, Agriculture and Healthcare.* 4**(15):**87-96. Retrieved (28 November, 2015).

Muralikrishnan, L 2021 Climate Change-Induced Drought Impacts, Adaptation and Mitigation *Sustainability* **2022.** 14(1)6., M. 2013. Zimbabwe Eyes Irrigation Law to Boost Farm Sector. Thomas Reuters Foundation.

Murwira, H. K., Mhaka, L. M., & Mano, R. 2016. Impact of agricultural training and extension services on smallholder farmers' performance in Zimbabwe. African Journal of Agricultural Research, 11(36), 3416-3423.

Mwendera, E. &Chilonda, P. 2013. Conceptual Framework for Revitalisation of Small-Scale Irrigation Schemes in Southern Africa. *Irrig. And Drain.***62**: 208-220. Doi; 10.1002/ird.1723

Nadler, L., & Nadler, Z. 1994. *Designing Training Programmes: The Critical Events Model*. Gulf Publishing Company. 280 pages.

Narayanamoorthy, A., Devika, N. & Bhattarai, M. 2016. More Crop and Profit per Drop of Water: Drip Irrigation for Empowering Distressed Small Farmers. *IMM Kozhikode Society & Management Review*. 5**(1):** 83-90.

Nataraj, N., Newsham, A., Rigg, J. 2022. *Susutainable Livelihood Framework*. World Development Bank, Elservier 155 (2022). 105898.

Nathan, L.L., Fredrick, O. & Niman, K. 2019. Interpreting Multiple Linear Regression: A Guidebook of Variable Importance. *Practical Assessment, Research & Evaluation:* 17(9).

Ndlovu, S.D. 2013. Teaching, Learning Psychomotor Domain for National Development. The Herald, Harare, Zimbabwe. http://www.herald.co.zw/teaching-learning-psychomotor-domain-for-national-develop... Accessed (17 July,2015).

Nelson, G. C., Palazzo, A., Ringler, C., Sulser, T. B., Batka, M., Mohamed, A., & Mason-D'Croz, D. 2020. The cost of being food insecure in Zimbabwe. Global Food Security, 27, 100410.

Nhundu, K., & Mushunje, A. 2010. Analysis of Irrigation Development Post Fast Track Land Reform Programme. A Case Study of Goromonzi District, Mashonaland East Province, Zimbabwe. Poster presented at the *Joint 3rd African Association of Agricultural Economists (AAE) and 48th Agricultural Economists Association of South Africa (AEASA) conference, Cape Town, South Africa, September 19-23.*

Nkabule, B.L. & Dlamini, C.S. 2013. Towards sustainable smallholder irrigation development projects: a case study of Maplotini Irrigation scheme, Swaziland. Journal of Agricultural Extension and Rural Development. 5**(7):** 216-224.

Nyerere, J.K. 1967. *Education for Self-Reliance: Freedom and Socialisation*. Oxford University Press, Dar es Salaam.126p.

Nzuma, J. M., Ndirangu, S. M., & Mutoko, M. C. 2019. Effect of group dynamics on smallholder farmers' access to agricultural training and adoption of improved maize production practices in Kenya. Journal of Agricultural Extension and Rural Development, 11(5), 107-116.

Oates, N., Mosello, B., Jobbins, G., 2017. Pathways for irrigation development: policies and irrigation performance in Tanzania (Working paper), Ground water Workshop. FANRPAN, Iringa.

Ogada, M.J., Nyangena, W. 2015. Impact of Improved Farm Technologies on Yields: The Case of Improved Maize Varieties and Inorganic Fertilizers in Kenya, in: Agriculture in an Interconnected World. Presented at the *International conference for agricultural Economists, Milan.*

Opportunity For Africa. 2022. Training for Farmers Report. 2022.

Oyelami, B., Akinwale, J., Ladele, A. 2018. Lead Farmer Extension Approach and Sustainable Extension Service Delivery in OYO State, Nigeria. Contemporary Agriculture. *The Serbian Journal of Agricultural Sciences.*

Panneerselvam, P., Hermansen, J.E., & Halberg, N. 2010. Food Security of Small Holding Farmers: Comparing Organic and Conventional Systems in India. Journal of Sustainable Agriculture, 351:**1,** 48-68.

Phillips, S.G. 2009. "Affective Learning in General Education". Special Topic Assessment in University General Program. 6**(1):** 1-44.

Pyburn, R., & Woodhill, J. (eds) 2014. *Dynamics of Rural Innovation: A Primer for Emerging Professionals.* LM Publishers, Arnhem.

Randall, V.R. 2011 Learning Domains or Bloom's Taxonomy. Big Dog's Bowl of Biscuits on http://www.nwlink.com/donclark. Accessed (25 March, 2015).

Ruhl, C. 2021. "Bloom's taxonomy of learning". *Simply Psychology*. Retrieved December 2015.

Rukuni, M., & Eicher, C. 2006. *Zimbabwe's Agricultural Revolution Revisited*. University of Zimbabwe Publications, Harare, Zimbabwe.

Rukuni, M & Eicher, C.K. 1994. *Zimbabwe's Agricultural Revolution*. University of Zimbabwe Publications, Harare, Zimbabwe. 418p.

Rukuni, M. 1986. The Evolution of Irrigation Policy in Zimbabwe: 1900-1986. Research on Irrigation in Africa. *Paper presented at the Forum on Irrigation Systems Research and Applications. Cornell University, USA. 32-42p*.

Ruzivo Trust, 2015. PIP Empowerment Factsheet: Agriculture Sector. Harare.

Sadza, Nherera, C M, Nhenga-Chakarisa, T, Munyuki-Hungwe, M. 2015. Zimbabwe Zero Hunger Strategic Review.

Sani, L. I., Oladokun, O. & Kalusopa, T. 2015. The role of Extension Workers in Akis based Irrigation Farming in Katsina State*. International Journal of Library Sciences.* 4**(2):** 28-34.

Scoones, I. 2015. *Sustainable Rural Livelihoods and Rural Development.* Winnipeg, CA. Fernwood Publishing.

Scoones, I. 2013. *Irrigating Zimbabwe: time for some new thinking*. Zimbabwe Land. Harare, Zimbabwe.

Sebaggala, R.& Matovu, F. 2015. The Effects of Agricultural Extension Services on Farm Yields in Uganda: Evidence from Agriculture Census Data.

SEEDCO Report, 2018. Harare, Zimbabwe. Zimbabwe Seed Company.

Serrat, O. 2008. *The Sustainable Livelihood Approach.* Knowledge Systems. Asian Development Bank.

Settle, W. 2014. Adapting to climate change. *Food & Agricultural Organisation*. Retrieved (16 April 2015).

Sewell, A.M., Hartnett, K., Gray, D.I., Blair, H.T., Kemp, P.D., Kenyon, P.R., Morris, S.T. & Wood, B.A. 2017. Using Educational Theory and Research to Refine Agricultural Extension: Affordances and Barriers for farmers' Learning and Practice Change. *Journal of Agricultural Education and Extension.* 23**(4**):313-333.

Siziba, S., Gombe, N. T., Gwambiwa, B., Chirundu, D., & Tshuma, C. 2020. Factors affecting smallholder farmer participation in maize markets and the impact on food security in Zimbabwe. Journal of Rural Studies, 73, 18-29.

Shamoo, A., Resnik, D. 2009. Responsible conduct of Research. 2nd ed. New York: Oxford Press.

Sharma, V.K., Vaid, A., Sharma, P.K., Ajrawat, B., Jamwal, A., Sharma, N., Mahajana, V., & Gupta, S. 2017. Impact assessment of training on farmers' perception, performance and entrepreneurship development. *Maharashtra Journal of Agricultural Economics* 20**(2):** 154-156.

Shiferaw, B., Okello, J., Reddy, R. V., & Wani, S. P. 2011. Innovations in rural livelihoods and sustainable agriculture. Springer.

Sincero, S.M. 2011. Domains of Learning. University of Cincinatti, USA. http://www.experiment

Soneye, A.S.O. 2014. Farm Holdings in Northern Nigeria and Implication for Food Security: A Remote Sensing and GIS Assessment. *African Journal of Food, Agriculture, Nutrition and Development.* 14**(2).** 179-197.

Tandon, G.H., 2013. Irrigation Engineering Principles: Module 3. DarshanInstitute of Engineering & Technology.

Thompson, S. 2017. What is the Most Important Element of a Needs Analysis? Forrester TEI Report. USA.

Tittonell, P., Corbeels, M., van Wijk, M. T., Giller, K. E., & Mapfumo, P. 2020. Ecological intensification: A framework for sustainable and profitable agricultural intensification. Agricultural Systems, 177, 102731.

Troy, P. 2017. "Managing Wheel-Lines and hand-Lines for High Profitability" (http://irrigation.wsu.edu/Content/Fact-Sheets/Set-Move-Management.pdf).

Underhill, H. W. 1990. *Small-Scale Irrigation in the context of rural development*. IIMI Irrigation Network. 264p

United Nations Development Programme 2019. Zimbabwe human development report 2017: Climate change and human development—Towards building a climate-resilient nation. United Nations Development Programme Zimbabwe.

United Nations News. Climate Change in Africa can destabilize `countries and entre regions'. 8 September, 2022.

Urassa, K.J. 2015. Factors influencing maize crop production at household levels: A case of Rukwa Region in the southern highlands of Tanzania. *Afr. J. Agric. Res*. **10:** 1097–1106. https://doi.org/10.5897/AJAR2014.9262

USAID, 2014. United States Agency for International Development works to strengthen Ethiopia's pulses, oilseeds and spices sector. November 12,, 2014.

Van Eerde, D., & Thijs, A. 2013. Towards a learning theory-based training approach. Journal of Workplace Learning, 25(3), 167-180.

Vincent, V. & Thomas, R.G. 1961. *An Agricultural Survey of Southern Rhodesia. Part I Agro-Ecological Survey*. Government Printers, Harare. 147p.

Waddington, S. R., Snapp, S., Kanyama-Phiri, G. Y., & Kumwenda, J. D. 2018. Learning to do it better: Experiential learning in maize production in Malawi. International Journal of Agricultural Sustainability, 16(2), 154-168.

Wagner, C., Kaluwich, B., & Garner, M. 2012. *Doing Social Research: A Global Context*. Mc Graw-Hill, London. 352p.

Webuadmin, 2015. What are the Different types of Farm Irrigation Systems?

Wise, G. 1998. *Community Development, Extension Environmental Education*. University of Wisconsin. USA. 182p.

World Food Program 2017. World Hunger and Poverty Facts and Statistics.

Wossen, T., Berger, T., & Di Falco, S. 2017. Social capital, risk preference and adoption of improved farm land management practices in Ethiopia. Agricultural. incomplete

Yadav, D.S., Sood, P., Thakur, S.K. & Chaudhary, A.K. 2013. Assessing the Training Needs of Agricultural Extension Workers about Organic Farming in the North-Western Himalayas. *Journal of Organic Systems.* 8**(1)**:17-27. Retrieved (30 June, 2015).

Zawe, C., Madyiwa, S., & Matete, P. 2015. *Trends and Outlook: Agricultural Water Management in Southern Africa.* Country Report Zimbabwe.

Zhangazha, W. 2014. Rural Poverty on the rise in Zimbabwe. Zimbabwe Independent, 12 September 2014.

Zimbabwe Atlas 2016. Government of Zimbabwe 2016. Government Printers, Harare.

Zimbabwe's neglected elderly farmers. The New Humanitarian 2 September 2014. Emerald Publishing Limited 2020.

Zimbabwe Statistical Agency (ZIMSTATS) 2015. Government of Zimbabwe 2015. Government Printers. Harare.

Zimbabwe Statistical Agency (ZIMSTATS) Census 2014. Government of Zimbabwe 2014. Government Printers, Harare.

Zimbabwe Statistical Agency (ZIMSTATS). Government of Zimbabwe 2013. Government Printers, Harare.

Zimbabwe Vulnerability Assessment Committee. 2022. Rural Livelihoods Assessment Report. Harare.

Zimbabwe Voluntary National Review 2021. Government Printers, Harare.

Zimbabwe Vulnerability Assessment Committee. 2020. 'Zimbabwe rural food security assessment, June 2020.' ZimVac, Report No. 8, Harare.

Zimbabwe Vulnerability Assessment Committee. 2017. 'Zimbabwe rural food security assessment, June 2017.' ZimVac, Report No. 5, Harare.

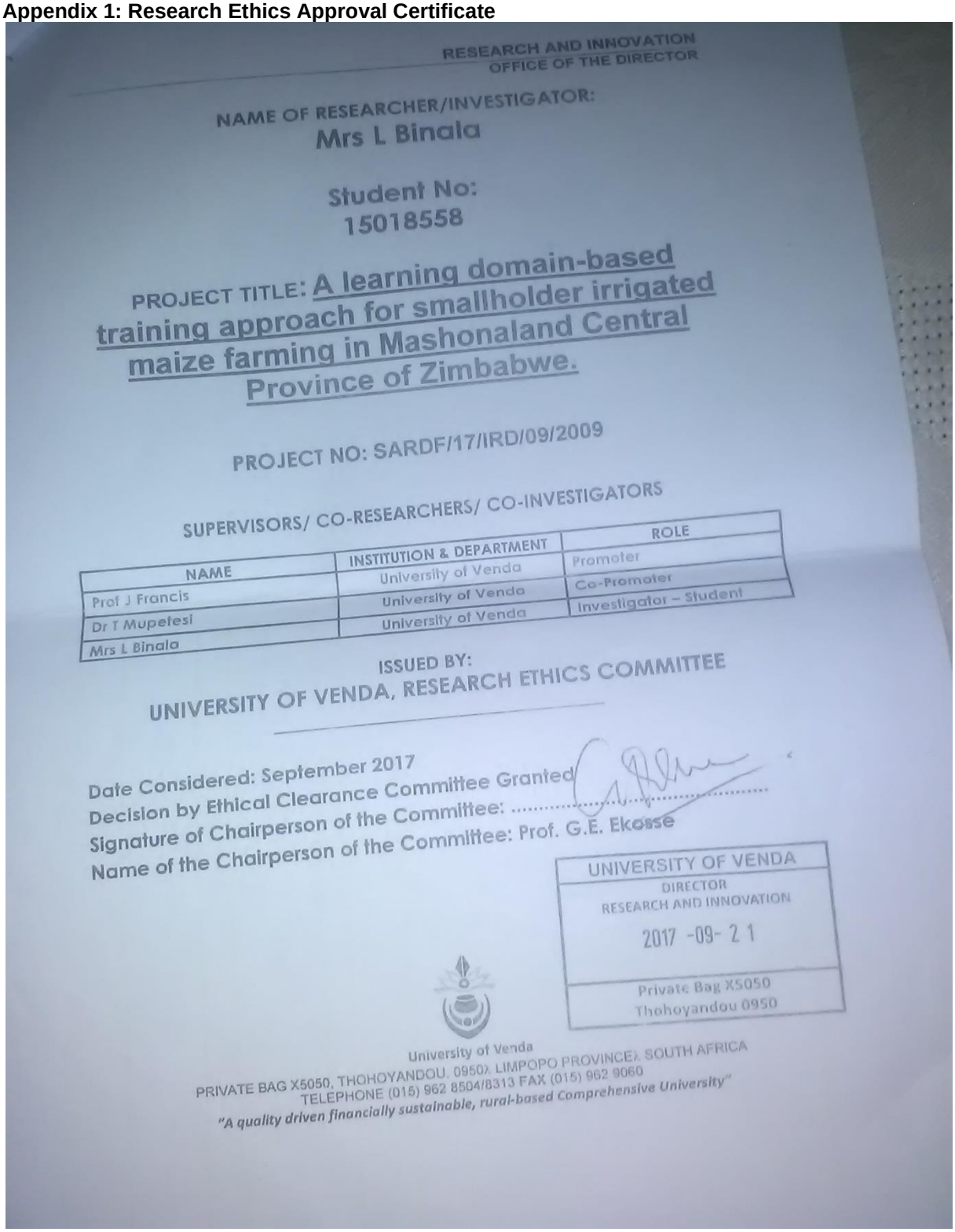
Zimbabwe Vulnerability Assessment Committee. 2014. Rural Livelihoods Assessment, Report. Food and Nutrition Council, Harare, Zimbabwe. 135p.

Zhou, Y., Sun, X., & Zhang, L. 2019. Credit constraint and smallholder farmers' adoption of modern agricultural technology: Evidence from China. Journal of Rural Studies, 71, 1-10.

Zwick, T. 2015. "Training older employees: what is effective?" International Journal of Manpower. 36**(2)**:136-150.

APPENDICES

Appendix 1: Research Ethics Approval Certificate



RESEARCH AND INNOVATION
OFFICE OF THE DIRECTOR

NAME OF RESEARCHER/INVESTIGATOR:
Mrs L Binala

Student No:
15018558

PROJECT TITLE: A learning domain-based training approach for smallholder irrigated maize farming in Mashonaland Central Province of Zimbabwe.

PROJECT NO: SARDF/17/IRD/09/2009

SUPERVISORS/ CO-RESEARCHERS/ CO-INVESTIGATORS

NAME	INSTITUTION & DEPARTMENT	ROLE
Prof J Francis	University of Venda	Promoter
Dr T Mupetesi	University of Venda	Co-Promoter
Mrs L Binala	University of Venda	Investigator – Student

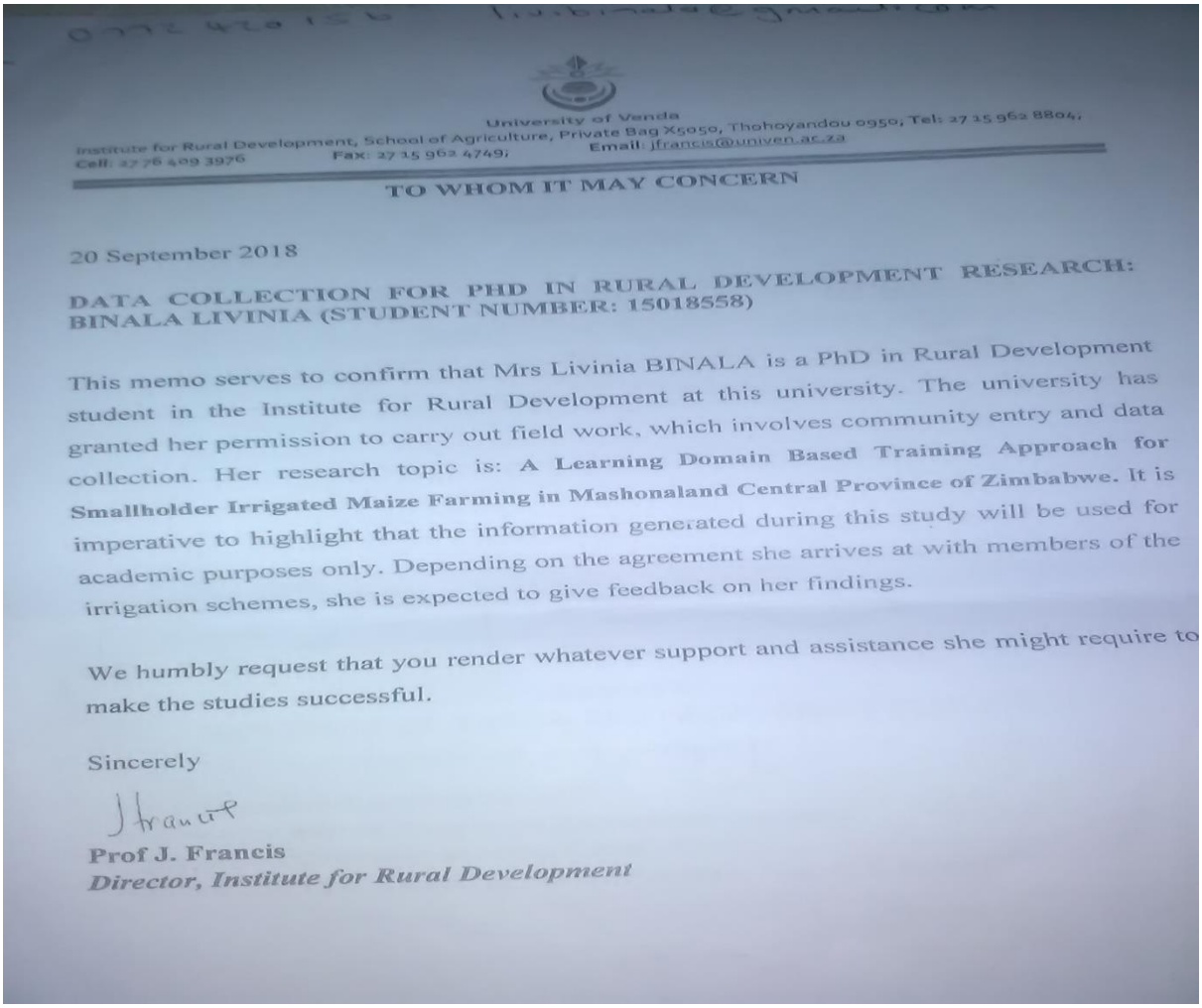
ISSUED BY:
UNIVERSITY OF VENDA, RESEARCH ETHICS COMMITTEE

Date Considered: September 2017
Decision by Ethical Clearance Committee Granted
Signature of Chairperson of the Committee: .....
Name of the Chairperson of the Committee: Prof. G.E. Ekosse

UNIVERSITY OF VENDA
DIRECTOR
RESEARCH AND INNOVATION
2017 -09- 21
Private Bag X5050
Thohoyandou 0950

University of Venda
PRIVATE BAG X5050, THOHOYANDOU, 0950, LIMPOPO PROVINCE, SOUTH AFRICA
TELEPHONE (015) 962 8504/8313 FAX (015) 962 9060
"A quality driven financially sustainable, rural-based Comprehensive University"

Appendix 2: Clearance letter from IRD Department



University of Venda
Institute for Rural Development, School of Agriculture, Private Bag X5050, Thohoyandou 0950; Tel: 27 15 962 8804;
Cell: 27 76 409 3976 Fax: 27 15 962 4749; Email: jfrancis@univen.ac.za

TO WHOM IT MAY CONCERN

20 September 2018

DATA COLLECTION FOR PHD IN RURAL DEVELOPMENT RESEARCH: BINALA LIVINIA (STUDENT NUMBER: 15018558)

This memo serves to confirm that Mrs Livinia BINALA is a PhD in Rural Development student in the Institute for Rural Development at this university. The university has granted her permission to carry out field work, which involves community entry and data collection. Her research topic is: **A Learning Domain Based Training Approach for Smallholder Irrigated Maize Farming in Mashonaland Central Province of Zimbabwe.** It is imperative to highlight that the information generated during this study will be used for academic purposes only. Depending on the agreement she arrives at with members of the irrigation schemes, she is expected to give feedback on her findings.

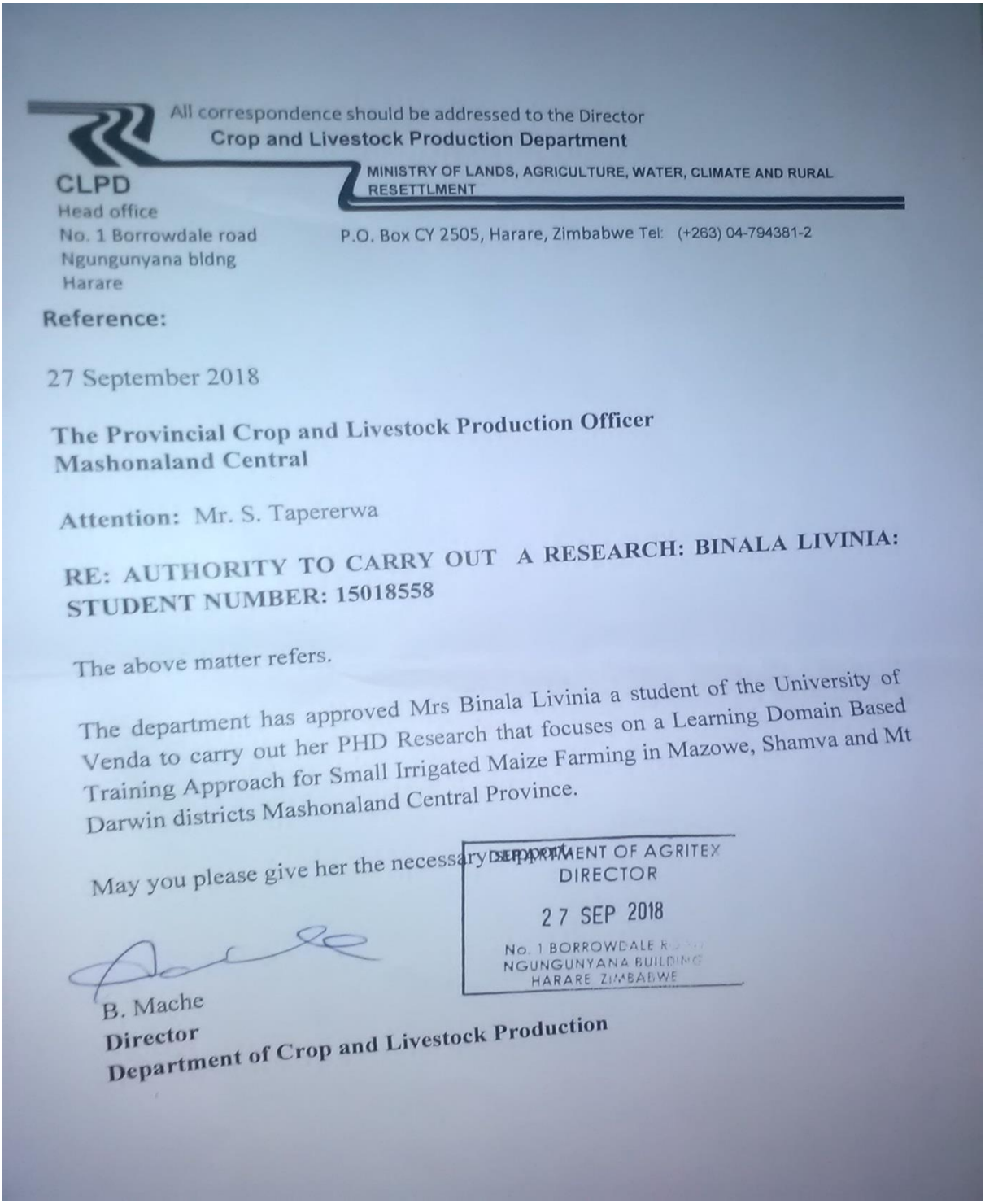
We humbly request that you render whatever support and assistance she might require to make the studies successful.

Sincerely

J Francis

Prof J. Francis
Director, Institute for Rural Development

Appendix 3: Clearance letter from MoAMID



All correspondence should be addressed to the Director
Crop and Livestock Production Department

MINISTRY OF LANDS, AGRICULTURE, WATER, CLIMATE AND RURAL RESETTLMENT

CLPD
Head office
No. 1 Borrowdale road
Ngungunyana bldng
Harare

P.O. Box CY 2505, Harare, Zimbabwe Tel: (+263) 04-794381-2

Reference:

27 September 2018

The Provincial Crop and Livestock Production Officer
Mashonaland Central

Attention: Mr. S. Tapererwa

RE: AUTHORITY TO CARRY OUT A RESEARCH: BINALA LIVINIA: STUDENT NUMBER: 15018558

The above matter refers.

The department has approved Mrs Binala Livinia a student of the University of Venda to carry out her PHD Research that focuses on a Learning Domain Based Training Approach for Small Irrigated Maize Farming in Mazowe, Shamva and Mt Darwin districts Mashonaland Central Province.

May you please give her the necessary support.

DEPARTMENT OF AGRITEX
DIRECTOR
27 SEP 2018
No. 1 BORROWDALE R...
NGUNGUNYANA BUILDING
HARARE ZIMBABWE

B. Mache
Director
Department of Crop and Livestock Production

APPENDIX 4: QUESTIONNARE FOR HOUSEHOLD INTERVIEWS

A LEARNING DOMAIN-BASED TRAINING APPROACH FOR SMALLHOLDER IRRIGATED MAIZE FARMING IN MASHONALAND CENTRAL PROVINCE OF ZIMBABWE

RESPONDENT_____

My name is …… We are conducting a socio-economic survey in Mashonaland Central chosen irrigation schemes. The researcher Livinia Binala, is a PhD student in Rural Development at the University of Venda, South Africa carrying out a study that aims to find out how the learning domains (cognitive, affective, psychomotor) can be applied in the training of farmers in irrigated maize farming in Small Scale Irrigation Schemes in Mashonaland Central Province. Your participation and input will contribute greatly to the body of knowledge and planning better programmes that may be used for any subsequent development initiatives aimed at alleviating household food security in Mashonaland Central in particular and Zimbabwe in general. Be guaranteed that the information collected from this interview will remain confidential and will be used solely for academic purposes only. The researcher therefore requests your voluntary and faithful participation. Would you like to participate in the survey as your household was among the selected households that are participating in maize irrigation? Please indicate by marking
[Yes] [No]. Thank you!

A: QUESTIONNAIRE IDENTIFICATION

A1. ENUMERATOR'S NAME						
A2. DISTRICT NAME						
A3. HOUSEHOLD NAME						
A4. RESPONDENT'S FULL NAME						
A5. DATE OF INTERVIEW						
A6. NAME OF IRRIGATION SCHEME						
A7. SIZE OF HOUSEHOLD						
A8. PLOT SIZE (HA)						
A9. TOTAL UTILISED LAND	2015		2016		2017	
A10. DISTANCE FROM THE NEAREST GROWTH POINT/TOWN (KM)						
A11. AGRO-ECOLOGICAL REGION	1 = II	2 = III	3 = IV			
A12. MODE OF MAIZE DELIVERY	1 = ANIMAL DRAWN CART 2 = MOTOR VEHICLE 3 = OTHER (SPECIFY)					
A13. DISTANCE FROM GMB (KM)						

Instructions: Circle the right answer

Section B. DEMOGRAPHIC DETAILS OF HOUSEHOLDS AND CHARACTERISTICS

B1. Age of household head (pick one)

1 = Younger than 25	2 = 26-35	3 = 36-45	4 = 46-55	5 = 56-65	6 = Older than 66

B2. Gender of household head (pick one)

1 = Male	2 = Female

B3. Marital status of household head (pick one)

1 = Single	2 =Married	3 = Divorced/Separated	4 = Widowed	5 = Single	6 = Never married

B4. Position of respondent in household

1 = Household head	2 = Spouse of head	3 = Brother	4 = Sister	5 = Son	6 = Daughter	7 = Other: Specify

B5. Number of permanent household members who are

Age/Gender (years)	0-15	16-64	65 +
Male			
Female			
Disabled			
Total			

B6. What is the total number of children in this HH [ ]

B7. Highest educational qualification of HH head (pick one)

0 = Primary	1 = ZJC/Std 6	2 = Secondary	3 = Tertiary	4=Degree	5 = Other specify

B8. Please indicate if you have other source(s) of income besides farming

YES [ ] NO [ ]

B9. If YES that of the following would describe these activities?

1 = Cross boarder trader	2 = Paid NGO work	3 = Politics
4 = Paid employment	5 = Volunteer	6 = Other specify

B10. What is the main material used for the main house?

1 = Stone	2 = Cement blocks
3 = Bricks	4 = Pole and dagga
5 = Other (specify)	

B11. Type of main roof material used on the main house (circle appropriate)

1 = Grass thatching	2 = Corrugated iron sheets
3 = Asbestos sheets	4 = Tiles
5 = Other (specify)	

B12. Type of toilet owned (circle appropriate)

0 = None	1 = Pit latrine	2 = Bucket system
3 = Blair	4 = Bush	5 = Other

B13. Household utensils, equipment owned (1 = Yes, 0 = None)

Domestic assets	Response	Productive assets	Response
Borehole		Rainwater tank	
Fuel/paraffin,/firewood/dung/coal stove		Cultivators	
Generator		Ploughs	
DVD/CD player		Watering Cans	
Table and chairs		Tractor	
Sofas		Wheel barrow	
Radio		Hoes	
Cellphone		Crop sprayer	
Television		Grinding mill	
Solar		Spades/shovels	
		Sewing machine	
Transport			
Scotch cart/Ox driven cart			
Car/Truck			
Motorcycle			
Bicycle			

B14. Health of household pets

Dogs/Cats	1 = Good	2 = Satisfactory	3 = Bad

B15. Do you belong to any of these social groups? (circle applicable)

1 = Farmers group	2 = Farming cooperative
3 = Burial society	4 = Church (Specify)
5 = Women's group	6 = Communal saving
	7 = Other (specify)

15. If yes, number of years in the group ……...

16. Are you a member of the IMC? 1 = Yes 0 = No

17. What position do you occupy in the IMC?

1 = IMC Chairperson	2 = Vice Chairperson
3 = Treasurer	4 = Secretary
5 = Vice Secretary	6 = Committee member
7 = Ordinary Member	

Section C: MAJOR INDICATORS OF EFFECTIVE FARMER TRAINING

C1. The type of agricultural training offered?

0 = None	1 = Trainee Master Farmer
2 = Master Farmer Certificate	3 = Advanced Master Certificate
4 = Training of Trainers	5 = Farmer Field School

C2. Of the following that training programmes did you attend?

Type of Training	Attended 1 = Yes 0 = No	Duration 1 = 1 day 2 = 2 days 3 = 3 days 4 = 1 week 5 = other	Frequency 1 = 1 daily 2 – twice/wk 3 = weekly 4 = fortnightly 5 = monthly 6 = quarterly 7 = once a year	Source of training 1 = AGRITEX 2 = NGOs 3 = Lead Farmers 4 = Manufacturer 5 = Local agro-dealer 6 = Wholesaler 7 = Other	Evaluation of training 1 = Very good 2 = Good 3 = Satisfactory 4 = Poor 5 = Very poor
ToT					
Bookkeeping					
Pest Management					
Postharvest management					
Water Management					
Farming as a Business					
None					

C3. If no, why did you not attend?

1 = Was not aware	2 = Busy	3 = Not interested	4 = Was trained before	5 = Other (specify)

C4 How were the farmers selected for training?

1 = By age	2 = By gender	3 =Plot holders	4 = Political	5 = Volunteers

C5. Adoption of Innovation

1 = Fully adopted	2 = Partially adopted
3 = Adopted and then stopped	4 = Never adopted but willing to adopt
5 = Never adopted and not willing to adopt	

C6. Was the information easily comprehensible?

0 = No	1 = Yes

C7. Please comment on the implications of the training to your production levels and livelihood?

1 = Very Good	2 = Good	3 = Satisfactory	4 = Poor	5 = Very Poor

Section D. PERCEIVED EFFECTIVENESS OF CURRENT TRAINING APPROACHES

D1. What are the current approaches in use?

1 = Master Farmer Scheme	2 = Innovation Platforms	3 = Field Days	4 = Farmer Field Schools

D2. Which of the training approaches are you comfortable with?

1 = Master Farmer Scheme	2 = Innovation Platforms	3 = Field Days	4 = Farmer Field Schools
Explain your answer			

D3. That of the training approaches do you consider best?

1 = Master Farmer Scheme	2 = Innovation Platforms	3 = Field Days	4 = Farmer Field Schools
Justify your choice			

D4. That of the following extension methods were used?

1 = Group methods (demonstrations)	2 = Individual Methods	3 = Mass media (TV, radio)	Others (specify)

D5. Crop production in (kgs) during the 3 year period

Area of maize grown (ha)	Total production (kgs)		
	2013	2014	2015

D6. What is your rating on the maize production in the last 3 years?

1 = Very Poor	2 = Poor	3 = Average	4 = Successful	5 = Very Successful	6 = Neutral

D7. If production was poor or very poor, what have been the contributing factors to the situation?

Reason	0 = No 1 = Yes
No inputs	
Lack of labour	
Drought	
Floods	

D8. How many meals do you normally have in a day?

1 = 1 2 = 2 3 = 3 4 = 4

D9. That of the following food items did your household consume in the last seven days?

Food item	0 = No	1 = Yes	No of days
Maize			
Sadza			
Mangai			
Maize porridge			
Rice			
Sorghum			
Millet			
Pasta			
Bread			
Potatoes			
Cassava			
Sweet potatoes			
Other tubers			
Beans			
Peas			
Groundnuts			

Fruits			
Meat			
Milk			
Sugar			
Oils			
Peanut butter			
Margarine			
Tea			
Coffee			
Salt			

D10. What is the source of the main food consumed? Tick the appropriate answer.

Source		
Own production	1	
Remittances from within Zimbabwe	2	
Remittances from outside Zimbabwe	3	
Purchases (cash and barter)	4	
Government Food Aid	5	
NGO food aid and assistance	6	
Grain loan scheme	7	
Gifts from well wishers	8	
Labour exchange	9	
Borrowed	10	
Hunting and gathering from the wild	12	
Other	13	

D11a. In the last 12 months, have you faced a situation where you failed to have enough food for your HH? 0 = No 1 = Yes

D11b. That months did the HH had adequate food? Circle your answer.

1 = Jan 2017	2 = Feb 2017	3 = Mar 2017	4 = Apr 2017	5 = May	6 = June
7 = July	8 = Aug	9 = Sep	10 = Oct	11 = Nov	12 = Dec

D12. Was production better when you attended training or even without training?

D13. What caused this shortage? Indicate at least 3 in order of importance using the codes

1	Inadequate HH food stocks due to drought	
2	Inadequate food stocks due to crop pest damage	
3	Inadequate food stocks due to large dependency ratio	
4	Inadequate food stocks due to lack of inputs	
5	Unable to reach the market due to transportation costs	
6	Food in the market was very expensive	
7	No food in the market	
8	Floods	
9	Other	

D14. Do you sometimes get grain surplus? 1 = YES 0 = NO

D15. What is your average income from the sale of surplus produce? ……

D16. How is the income used?

School Fees	Food	Health Care	Inputs	Debt payment	Input loan scheme

D17. That of the following provides a ready market for your produce?

Private Millers	GMB	Other farmers	Other : (Specify)

Section E. LEVEL OF FARMERS' EDUCATION, SKILLS, ADOPTION, KNOWLEDGE,

ATTITUDES AND PRACTICES (KAP)

E1. What is your level of education? Circle the appropriate answer.

University	Diploma	A level	O level	None	Other (specify)

E2. That of the following skills did you acquire through training?

	0 = No 1 = Yes
Farming as a business	
Knowledge and self- reliance	
Record-keeping	
Viability assessment	
Pest management	
Timely harvesting	
Post-harvest management	

E3. In general, how do you perceive the skills imparted to you?

1 = Satisfactory	2 = Good	3 = Very Good	4 = Poor	5 = Very Poor	6 = Neutral

E4. That of the following did you adopt?

	0 = No 1 = Yes
Farming as a business	
Knowledge and self- reliance	
Record-keeping	
Viability assessment	
Pest management	
Timely harvesting	
Post-harvest management	

E5. Do you think the following are important in maize irrigation?

	1 = Strongly Disagree	2 = Disagree	3 = Neutral	4 = Agree	5 = Strongly agree
Farming as a Business					
Knowledge and self- reliance					
Record-keeping					
Viability assessment					
Pest management					
Timely harvesting					
Post-harvest management					

E6. What is your rating on the instructor's skills of teaching?

Satisfactory	Good	Very Good	Poor	Very Poor	Neutral
1	2	3	4	5	6

E7. That methods do you prefer (in order of preference?

	Instructional methods used	Preference Ranking
Lecture		
Demonstration		
Role playing		
Drama		
Groups		
Individual Assignments		

E8. What best describes what you do when you realize that you need some agricultural information?

Read books	Consult institutions	Consult colleagues	Consult extension officers	Other (specify

1	2	3	4	5

E9. Do you have access to information that you need?

1 = Always	2 = Sometimes	3 = Never

E10. In what language is the information presented to you?

English	Shona	Ndebele	Other specify
1	2	3	4

E11. What is your opinion on how to improve the farmer skills acquisition?

	1 = Strongly Disagree	2 = Disagree	3 = Neutral	4 = Strongly Agree	5 = Agree
Access to public extension workers					
Access to farmer-led extension services					
Access to market information					
Use of comprehensible language					

Thank you for your time!

APPENDIX 5: Target Key Informants

[Director, Farmer Training [MOAMID), Provincial Representatives of the Ministry of Agriculture, Mechanisation and Irrigation Development/IFAD/FAO/ Chiefs/ NGOs/ Research Institutions]

Introduction

The objective of this interview guide is to get information relating to agricultural extension, specifically focusing on the training of smallholder farmers in irrigation schemes. Follow up questions may be asked depending on the nature of the key informant interviews. These questions may not necessarily be in the interview guide.

NAME OF KEY INFORMANT	
OCCUPATION	
LOCATION	
ORGANISATION	
TELEPHONE NUMBER	
CELLPHONE NUMBER	
E-MAIL ADDRESS	

A. Overview of the Small Irrigation Schemes in Mashonaland Central

- No of plot holders
- the ACT that governs small holder irrigation sub-sector (From Ministry)
- Farming systems
- Existence of plans for settlements, replication
- Irrigation demarcation
- Administration (IMC, Chief, Village headman) roles
- Infrastructure (schools, churches)
- What is the government's position on SIS?
- Is there any documentation for reference?

B. Indicators of an effective smallholder maize farmer in an irrigation scheme

Performance of farmers varies greatly. While others are regarded as effective or successful, others are viewed as ineffective.

- What criteria or indicators best describe an effective smallholder farmer in an irrigation scheme?
- That ones are the most important criteria?
- Why do farmers differ in their effectiveness?
- What strategies can be adopted to make farmers more effective?

Delivery of smallholder irrigated maize farmer training programmes

- What training programmes are there for farmers involved in smallholder irrigation?
- What type of training is offered?
- Who provides such training? - farmer researcher linkages
- What training methods are used?
- Who decides on the training to be offered?
- Is there a unit that is responsible for farmer training?
- Effectiveness of farmer training programmes
- What is the duration of the training programmes and mode of communication?
- What can you say about the quality of farmer training programmes being offered?
- What is the level of effectiveness of training? (KSA, adoption rate)
- What is your assessment of crop production after training sessions in the past three years (2015, 2016, 2017)?
- How do the farmers and government address the challenges, if any?
- What strategies are used to ensure that agricultural extension officers remain abreast with knowledge and other aspects required to enhance the performance of smallholder irrigation schemes?
- What additional training do agricultural extension officers received?

C. Perceived impact of current training approaches

- What are the trends in irrigated maize production basing on different approaches used?

Training approach	Maize yields (50 kg bags)	Year		
		2015	2016	2017

- In your opinion that of the training approaches do you consider best? (Please rank (1 = very good, 2 = good, 3 = satisfactory)
  Please explain your ranking …….
- In the event of maize surplus, who are the major buyers of the produce?
- As a stakeholder do you think the training approaches are appropriate for the targeted population?
- What do you think should be done to improve the agricultural training in SIS?

D. Level of farmers' education, skills adoption, knowledge, attitudes and practices (KAP)

- What is the criteria in choosing plot holders?
- Do the farmers have specialized training in agriculture?
- How do you rate the level of farmers' skills in the SIS?
- How are the training sessions programmed? (instructional methods, when, language)
- What are the major good agricultural practices for irrigated maize production (at least 10 GAPs)
- How should access to agricultural information be provided to enhance output and food security in smallholder irrigated maize farming?
- How do you ensure that there is adequate access to agricultural information particularly for irrigated maize farmers against a huge backdrop of low literacy levels?
- What is your assessment of smallholder farmers' knowledge, attitudes and practices (KAP) with regards to these GAPs? (e.g. irrigation scheduling – KNOWLEDGE AND ATTITUDE INFORM PRACTICE)
- What specialized technical skills do extension officers must acquire in order for them to serve better?
- What is the gender distribution of farmer-extension officer in Mashonaland Central?

E. Proposed improved training framework

- Would you please comment on the strengths and weaknesses of the current training framework?

- In your view what do you think should be done to improve the way training of smallholder maize farmers in irrigation schemes is done?
- What might make it difficult to implement the strategies for improved training of the farmers?

APPENDIX 6: Interview guide for the agriculture extension worker responsible for the irrigation scheme

NAME OF EXTENSION OFFICER	
SCHEME	
AGE	
GENDER	
EDUCATIONAL QUALIFICATIONS	
TELEPHONE NUMBER	
CELLPHONE NUMBER	
E-MAIL ADDRESS	

1. For how long have you operated in the district
2. As an extension worker what activities are you involved in?
3. What have been the significant achievements during your tenure?

A. Indicators of effective training

4. Would you like to comment on the farmer training programmes in the scheme?
5. Would you please comment on the level of participation by the farmers?
6. How long are the training programmes?
7. How frequent are they offered?
8. How are these organised and conducted?
9. How do you rate the adoption levels by farmers?
10. How do you meet your role as an agriculture information support system?
11. What do you think were the implications of the training programmes to the farmers' livelihoods?

B. Perceived impact of current training approaches

12. What are the current approaches in use?
13. To what extend do they affect maize production in the scheme?
14. What is the distribution of extension officers in the District and Mashonaland Central in general?
15. How do farmers receive female and young extension officers?
16. Of the training approaches available that one(s) do you think is/are the most effective one/s?
17. What is your rating on the maize production in the last three years? (2015,2016, 2017)

C. Levels of farmers' skills

18. What type of agricultural knowledge do the farmers possess?
19. As an extension officer, do you think you are closing the gap that exist in the farmers?
20. In conducting training sessions, do you consider the mental capabilities of the farmers? ((how)
21. How do you ensure that there is access to agricultural information to all farmers?
22. Are there mechanisms to evaluate information use or application?
23. How accessible are extension officers?
24. What have been the challenges that you faced in trying to enhance adoption by farmers?

D. Proposition of an improved training framework

25. Please elaborate on the features of the current training framework
26. What would you consider as strengths and weaknesses of the current framework
27. In your, opinion, what do you think should be done on training framework to ensure optimal maize output?
28. Are there any other comments that you would like to make that have not been covered by this questionnaire?

APPENDIX 7. Themes for focus groups

1. Effectiveness and efficiency of training programme
    - Current training programme: (relevance, appropriateness)
    - Factors in participant selection
    - Adoption levels of new technologies
    - To what extent did the programme meet its set target and objectives? (Crop production levels (food sufficiency indicators, food scarcity indicators)
    - How effective was the training programme in terms of staffing (NGOs, Extension officers)
    - How effective were the training programmes in addressing the issue of climate change? (Disaster Risk Reduction)
2. Impact of training approach
    - What difference has the programme made to beneficiaries?
    - How do previous yields compare with after training production?
    - Where there is significant change, how much can be attributed to the training? (Show evidence)
    - How has the interventions impacted on young people, men, women and people living with disabilities?
    - Impact on beneficiaries – positive, negative (ability to use CAP)
3. Skills Acquisition
    - How critical were issues of lack of agricultural knowledge prior to training?
    - To what extend did the programme address the level of capabilities and abilities in farmers?
    - How accurate has the programme been at targeting the skills deficiency?
    - How was the targeting done and was it appropriate? (Needs assessment)
    - How appropriate was the intervention to different groups (young people, men, women and people with disabilities)
    - How has the target groups participated in different programme interventions?
    - Availability of agricultural information
    - Access and utilization of Agricultural information
    - What other aspects should be included when training SIS farmers?
4. Proposed training framework
    - Would you recommend continuing with the current training framework?
    - That of the approaches do you think could best improve agricultural production
    - Challenges faced with current framework
5. Recommendations
    - What do you think can be done to make training of farmers be in line with the levels of the mind of participants?
    - What other methods do you think may be used to in farmer training?

Appendix 8: Profiles of Irrigation Schemes

	PROJECT NAME/scheme	LAND SIZE (Ha)	DISTRICT	No. of BENEFICIARIES	YEAR	TRAININGS OFFERED	DIST. FROM HARARE	CROPPING	MALE (%)	FEMALE (%)
1	TSAKARE A	20	MT. DARWIN	40	1998	O&M	200	see list below	80	20
2	DOTITO	30	MT. DARWIN	60	2006	O&M	210		78	22
3	MUTONDWE	10	MT. DARWIN	20		O&M	190		85	15
4	MUDOTWE	64	SHAMVA	32		O&M	70		85	15
5	CHIMHANDA	67	RUSHINGA	134	1992	O&M	250		75	25
6	PRINCIPE A	30	SHAMVA	60	1993	O&M	120		90	10
7	PRINCIPE B	30	SHAMVA	60	1993	O&M	120		88	12
8	MAZIVANDAGARA	10	SHAMVA	20	2000	O&M	140		85	15
9	NEGOMO	394	MAZOWE	296	1996	O&M	90		80	20
10	BANANA	20	SHAMVA	40	2011	O&M + TFT	125		80	20
11	EBEN	20	SHAMVA	40	2011	O&M + TFT	125		75	25
12	PFUNYANGUWO	5	MT. DARWIN	10	2005	O&M	300		85	15
13	GUTSA	12	MUZARABANI	30	2014	O&M	350		85	15
14	CHIPA	86	MT. DARWIN	41	2005	O&M	160		10	10
15	TSUNDA	40	BINDURA	113	1990	O&M	90		10	10
16	Chibuli	50	Mt Darwin	33		O&M	220		91	9

O&M-OPERATION AND MAINTENANCE, TFT-TRAININGFOR TRANSFORMATION

CROPPING IS GENERALLY-

Grain Maize			t/ha	6
Groundnuts			t/ha	1.8
Tomatoes			t/ha	27
Onion			t/ha	22.5
Cabbage			Heads	27,000
Dry beans			t/ha	1.8
Green Maize			cobs/ha	39,600

Appendix: 9 Maize field at Chimhanda Irrigation Scheme showing wilting maize

ZIMBABWE EZEKIEL GUTI UNIVERSITY

Zimbabwe Ezekiel Guti University
Stand No. 1901 Barrassie Road
Off Shamva Road
P.O.Box 350
Bindura
Zimbabwe
Tel: +263 867 700 6136
Cell: +263 779 279 912
Email: jchirisa@zegu.ac.zw
innocent.chirisa@gmail.com

OFFICE OF THE PRO VICE CHANCELLOR-ACADEMIC

28 February 2023

Dear Sir/Madam

CONFIRMATION OF PROOF READING AND EDITING OF PHD THESIS

This letter confirms that I proofread and edited the following thesis, using the Windows "Tracking" system to reflect my comments and suggested corrections for the student to action. I also offer the overall language and technical editing of the whole thesis.

Name of Student: Livinia Binala (Student Number: 154018558)

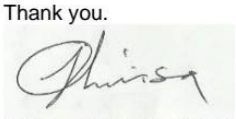
Degree: PhD in Rural Development

Institution: Institute for Rural Development, University of Venda

Topic: A Learning domain-based training approach for smallholder irrigated maize farming in Mashonaland Central Province of Zimbabwe

Supervisors: Prof J. Francis, Dr T Mupetesi

Thank you.



PROFESSOR I. CHIRISA

Qualification	PHDRDV	PHD IN RURAL DEVELOPMET			
Registration Year		2022	**Registration Dates**	06-Jan-2022 to 12-Dec-2022	
Academic Block	H4	DOCTORAL STUDENTS	**Faculty**	4000	SCIENCE, ENGINEERING AND AGRIC
Offering Type	08	DOCTORAL(SUCCESSIVE YEAR)	**Department**	4019	INSTITUTE FOR RURAL DEVELOPMEN
Period of Study	2	2ND YEAR	**Has Bursary**	N	

Subject Code	Description	Academic Block	Offering Type	Class Group	Prac Group	Tut Group	Attendance	Cancel Date	Att	Proj	Exam Granted	Exam Month	Half Period	Full Period	Final Mark	Result	Withheld Reasons
CRD7099	THESIS RURAL DEVELOPMENT	DOCTORAL STUDENTS	DOCTORAL(SUCCESSIVE YEAR)	A			NORMAL EXAM		0		No	11					Withhold examination results - Finance